

PROJECT MONOGRAPH

LAS POSAS PROJECT

GALIF 1.

VENTURA COUNTY, CALIFORNIA. REGION 10.

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

THE LAS POSAS PROJECT MONOGRAPH

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CONTENTS

	Page
INTRODUCTION	1
Location	3
Importance of the Location.	4
DESCRIPTION OF THE AREA.	6
Physiography.	6
Drainage.	9
Geology	10
Climate	12
Native Vegetation	15
Wildlife.	17
Economic and Social Conditions.	18
LAND UTILIZATION AND DEVELOPMENT	22
Aboriginal Period	22
Spanish - Mexican Period.	23
American Period	27
Grain Period	30
Bean Period - history; culture methods; hill land development; water development; recent changes in land-use.	34
THE PROBLEM OF SOIL EROSION.	45
The Conservation Survey	46
Soils	47
Erosion	59
Causes of Erosion.	59
Types of Erosion	62
Erosion Classes Mapped	64
Extent and Severity of Erosion	65
Relation of Erosion to Slope	67
Relation of Erosion to Land Use.	69
Relation of Erosion to Cropping Practices.	73
Relation of Erosion to Soils	78
Erosion Control by Farmers.	80

CONTENTS -- Cont'd --

	Page
THE WORK OF THE SOIL CONSERVATION SERVICE	83
Project Organization	84
Planning Soil Conserving Farm Programs	85
Soil Saving Treatment.	87
Control of Gully Erosion.	87
Control of Sheet Erosion.	99
Treatment of Annually Cropped Land	100
Mechanical Controls - terracing; tillage practices.	101
Agronomic and Vegetative Controls	108
Retirement of Annually Cropped Land - retirement to pasture; retirement to woodland	113
Treatment of Orchard Land	120
Pasture and Range Improvement.	122
Treatment of Idle Land	123
Wildlife Management	124
Fertilization	127
Investigational Studies	128
Evaluation Studies.	129
Coordination of Treatment	131
Educational Activities.	134
ACCOMPLISHMENTS AND RESULTS	136
Degree of Program Establishment.	136
Cooperation	139
Changes and Trends in Land Use, Erosion, Economic and Social Conditions.	142
Unsolved Problems	145
RECOMMENDATIONS	148
APPENDIX	157

FIGURES

Number	Page
1. Sketch maps showing location of the Las Posas project area and representative region	4-A
2. Partial panorama of the Las Posas area	7
3. Physiographic map of the Las Posas project area (see Appendix)	159
4. Typical drainage-way barranca.	9
5. Modelo shale formation	11
6. Native sagebrush cover protecting hillside land	15
7. Four important implements for soil and seed bed preparation on lima bean land.	37-A,B
8. Planting lima beans on hillside land	38
9. Irrigation map of the Las Posas project area (see Appendix)	160
10. Preventing erosion on hillside land by bench terracing	43-A
11-A. Generalized land use map of the Las Posas project area (see Appendix).	161
11-B. Generalized soils map of the Las Posas project area (see Appendix)	162
11-C. Generalized erosion map of the Las Posas project area (see Appendix)	163
12. Types of erosion.	62-A
13. Soil surface reduced to a relatively impervious condition by rainfall compaction	75
14. Erosion consequent to subsoiling up and down slope	77

TABLES

Number		Page
1.	Monthly, seasonal and annual temperature and precipitation at Somis, Ventura County, California	14
2.	Farms and acreage by type of ownership	19
3.	Farms classified according to type of owners and operators.	20
4.	Type of land utilization and approximate range in value per acre.	20
5.	Comparisons of exports of barley, wheat and corn from Port of Hueneme, 1880 and 1888	31
6.	Acreage and proportionate extent of land use by crops and classes	44
7.	Area and proportionate extent of soil types listed in order of increasing erosibility . .	53
8.	Area and proportionate extent of soil groups listed in order of increasing erosibility . .	56
9.	Distribution of soil groups in each slope class	57
10.	Acreage and proportionate extent of land use classes in each soil group.	58
11.	Acreage and proportionate extent of erosion classes	66
12.	Acreage and proportionate extent of erosion groups	66
13.	Distribution of erosion in each slope class .	68
14.	Distribution of land use in each slope class and in the entire project and percentage of total area in each slope class.	70
15.	Distribution of erosion in each land use class.	71

TABLES - Cont'd -

Number		Page
16.	Estimated average soil losses, season 1937-38	73
17.	Distribution of erosion in each soil group	79
18.	Soil conserving rotations	110
19.	Trees and shrubs which have indicated their adaptability for woodland plant- ing	117
20.	Plants which have indicated their adapta- bility for areas dedicated to wildlife. . . .	125
21.	Survival observations on forage adapta- tion plots.	130
22.	Summary of land conversions accompanying reorganized land use.	132-A
23.	Degree of program establishment	137
24.	Treatment and practice establishment.	138
25.	Classification of cooperative agreement farms by type of operator and type of cooperator	141
26.	Land conversions on cooperative agree- ment farms	143

THE LAS POSAS PROJECT MONOGRAPH

INTRODUCTION

*Too long?
by half?*

Soil erosion is not new to the farmer in the United States. From the earliest beginnings of colonial agriculture it has been an ever present but in most cases an unrecognized problem. The problem is defined in terms of the movement of soil by water or wind on land which, through man's unwise utilization or improper agricultural practices, has been subjected to erosional processes far above what would occur under natural conditions.

The treatment of land in a manner which has resulted in acceleration of the erosional processes is so general in the United States as to have reached the proportions of a National menace to the agricultural resources. In 1934, a reconnaissance soil erosion survey (1) disclosed that approximately 50,000,000 acres of once fertile and cultivable farm land had been essentially destroyed by gully erosion; that on another 125,000,000 acres the accumulated effect of storm waters had largely washed away a greater part of the productive top soils and that in addition 100,000,000 acres were rapidly being subjected to the agencies of accelerated erosion. These incalculable losses do not take into consideration the erosional damage occurring on the vast grazing domain of the West nor the effects of wind erosion in the Great Plains Area.

In California, man induced erosion occurs on over 47 percent of the total land area of 99,634,672 acres. Of the area unaffected by

(1) SOIL EROSION, A CRITICAL PROBLEM IN AMERICAN AGRICULTURE. Part V of the supplementary report of the Land Planning Committee to the National Resources Board. U.S. Government Printing Office, 112 pp. illus. 1935.

erosion, involving over 52,000,000 acres, some 19,000,000 acres are in National Forests. In the eroded areas a loss of from one-fourth to three-fourths of the top soil occurred on more than 34,000,000 acres, and in addition some 3,000,000 acres had lost over three-fourths of the top soil and some subsoil. Gullying was prevalent over more than 22,000,000 acres and very severe on more than 6,000,000 acres. Some 700,000 acres of agricultural land has been destroyed entirely by man induced erosion.

Results of erosional losses are directly reflected in land depreciation and reduced crop yields which on a country wide scale has been variously estimated at \$400,000,000 per annum. This is only part of the contribution of soil erosion to the ravishment of National resources. The siltation of reservoirs directly affecting water storage facilities for irrigation, domestic water supply, hydro-electric power and damages to navigable streams, rivers and harbors, the deposition of erosional debris on fertile lowlands and bottom lands, the accentuation of flood peaks by unimpeded runoff spreading havoc along river streams, all of these in common, have inflicted stupendous damages to permanent improvements and invested capital as well as contributing to human misery. Furthermore, under conditions of rapid runoff which cause and at the same time are augmented by erosion only a small portion of the total rainfall is absorbed by the soil and is beneficial to agriculture.

In response to the development of this acute problem the United States Department of the Interior, later succeeded by the United States Department of Agriculture, undertook to establish a program for combating the first phases of the problem, that is, accelerated soil erosion and kindred land use problems effecting such serious damage to farm, pasture and range land throughout the United States.

Early in 1933 a series of demonstrational project areas was established throughout the United States in representative erosion problem areas by a Bureau of the United States Department of Interior designated as the Soil Erosion Service which, under the Department of Agriculture, became the Soil Conservation Service to undertake development and application of soil conservation methods and practices under actual field conditions. These demonstrational project areas were set up for a period of five years, during which time an intensive program of development of soil conservation and land use practices was placed in effect with the cooperation of the farmers located within the boundaries of the demonstrational projects.

The Las Posas project area established early in 1934 was the first of such demonstrational areas in California. In a period of five years of operation of this project a great deal of significant and valuable information and data bearing upon the problems of soil erosion and its control has been obtained.

The purpose of the present project monograph is to relate:

- (1) The development of the soil erosion problem on the Las Posas project area.
- (2) The subsequent application of means and methods of attacking the problems.
- (3) The resultant accomplishments.
- (4) Recommendations of soil conservation practices applicable to areas of which the Las Posas project is representative.

Location

The Las Posas(2) demonstrational project area is located in the

uncertain.

(2) Spanish, meaning "the wells". ~~Probably derived from natural flowing springs which existed near Somis during the Spanish era. A greater part of the land in the project area lies in the Las Posas Valley and includes all of the subdivisions of the Las Posas Rancho, an original Spanish grant.~~

southwestern part of Ventura County, California about 10 miles inland from the Pacific Ocean and 60 miles northwest of Los Angeles.

The area is roughly rectangular in shape, being approximately 11 miles long and 6 miles wide. Santa Paula, Moorpark, Camarillo, and Saticoy are near the north, east, south, and west boundaries respectively. Somis, a small town of approximately 250 population, is within the boundaries of the project. Ventura, the county seat, is 15 miles northwest. Figure 1 shows the location of the Las Posas area with reference to the state and county. Inclusive of gullies, roads, and other miscellaneous areas, the project covers 38,488 acres or approximately 60 square miles and consists of a number of small watersheds tributary to the Arroyo Las Posas and the Las Posas Wash, both intermittent waterways draining the project area.

Importance of the Location

The selection of this location by the Federal Government as a site for a soil conservation demonstrational project area was predicated on two factors:

- (1) The magnitude and complexity of soil erosion problems are nowhere surpassed in the entire state. There are many sections where erosion is very active, but none where all the problems are found associated in so small an area. There is on this area, level, rich bottom land of high agricultural value, gently sloping mesa land, rolling hill land, steep hill land and mountainous uncultivated land; collectively these offered an opportunity for demonstrating every known type of erosion control.
- (2) The project location is representative of a region of highly

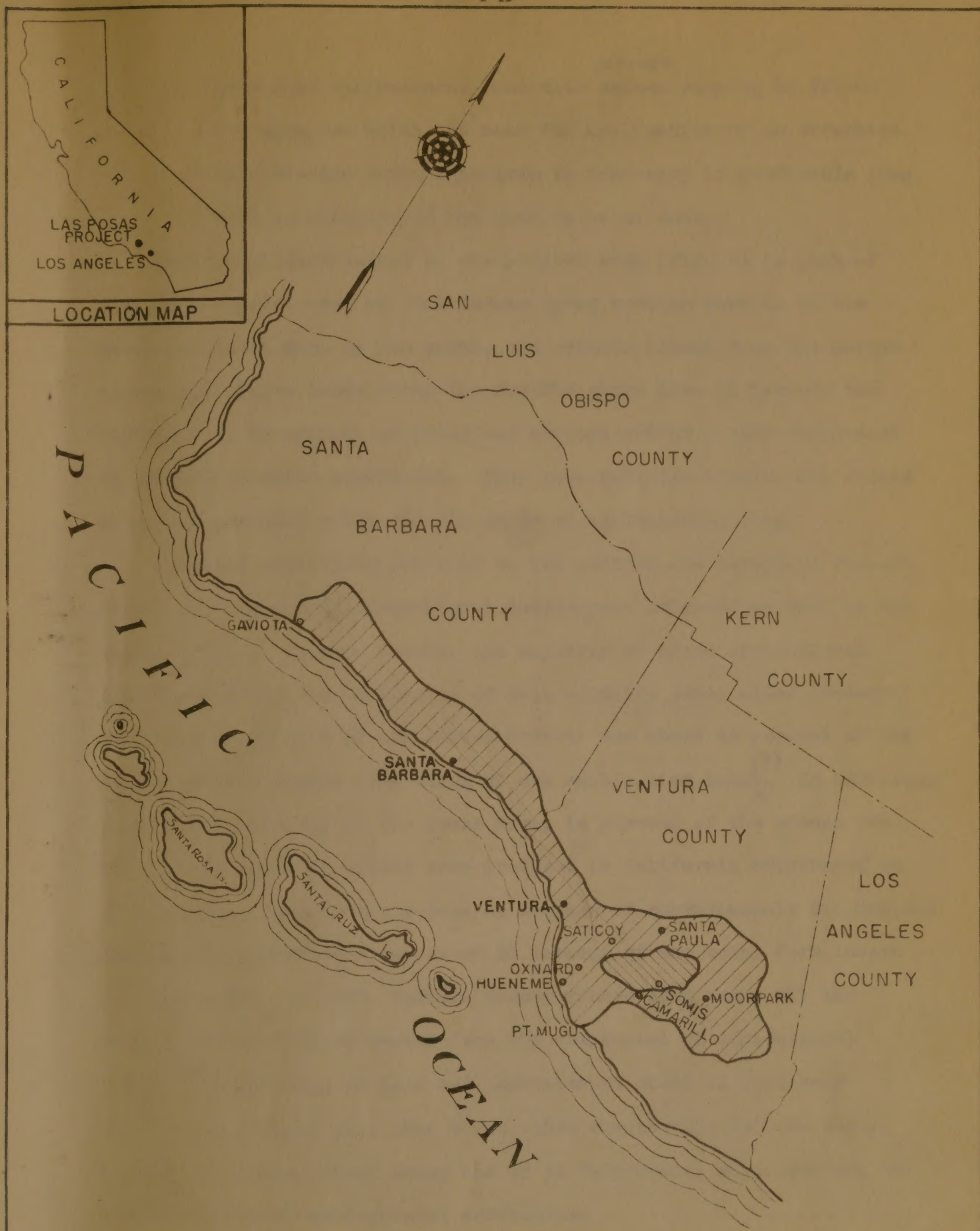


Figure 1. Sketch maps showing location of the Las Posas project area and representative region.

-  Las Posas project area.
-  Representative region.

developed agricultural land with ^{prices} ~~values~~ ranging to \$3,000 per acre, on which the need for application of an effective soil erosion control program is necessary if profitable long time utilization of the land is to be made.

The region represented by the project area (Fig. 1) is part of the south coastal area of California lying between Gaviota on the north and Point Mugu on the south, and extends inland from the marine terrace and delta lands along the Pacific shore line to include the differential topography of hills and valleys within a zone influenced by coastal climatic conditions. This area embraces roughly 660 square miles and includes about 300,000 acres of agricultural land.

Climatic conditions peculiar to the section are important factors in the high degree of agricultural development attained as well as the types evolved. Ventura County, the majority of whose agricultural land lies within the boundaries of this climatic zone, alone produces more than 50 percent of the United States' and about 44 percent of the entire world's annual production of dry edible lima beans. ⁽³⁾ In addition, more than 18 percent of the lemon crop, 14 percent of the orange crop, and 7 percent of the walnut crop produced in California originates in this county. These crops return an average of approximately \$16,000,000 annually to growers and represent 80 percent of the total farm income of the county. In 1930, Ventura County ranked 12th among all the counties of the United States from the standpoint of agricultural ⁽⁴⁾ returns. Valuations of land and improvements which in 1935 were \$52,300 per farm, or more than three times the average for the state, placing the county first among the 58 in California, also reflects the profitableness of agricultural activities.

Although the natural advantages of climate and soil have made possible the high development and profitable utilization of the land -

soil erosion, particularly on bean land, is ^{discovering} ~~causing the destruction~~ ^{destroying} ~~of economic land use~~ ^{utilization} and ^{suppressing} ~~with it the suppression of the climatic~~ ^{economic} advantage. ~~for~~ Without soil the ^{inherent in} values of climate ^{are reduced} ~~is lost to man's~~ ^{correspondingly.} ~~agricultural pursuits for centuries to come if not forever.~~

In order, therefore, to preserve the integrity of the ^{remaining} natural resources and to prevent further destruction of the land the Government established the Las Posas Soil Conservation Project on January 12, 1934 as a center for demonstrating and testing methods and practices of soil erosion control.

DESCRIPTION OF THE AREA

Physiography

The Las Posas area lies in the coastal foothill portion of the Southern California transverse ranges, a series of east-west trending ridges and valleys. In detail, the project area comprises a wide variety of surface features (Fig. 2) ranging from the lower valley floor with its associated marginal alluvial fans and mesa lands to the adjacent foothills and rough mountainous uplands.

These various units of relief are grouped into six physiographic ^{divisions} ~~provinces~~ (Fig. 3)* as follows:

1. South Mountain Range. An east-west trending ridge, rising abruptly from the foothill region to a maximum elevation of 2258 feet. The crest line of this unit forms the north boundary of the project and divides the drainage between the Las Posas and Santa Clara valleys. Slopes range from 40 to 100 percent. Agriculture is limited to grazing on less precipitous slopes.

2. Foothill Region. A belt of parallel hills and valleys

* See appendix



Figure 2. Partial panorama of the Las Posas area looking north from the summit of the Camarillo Hills. In the background is the South Mountain Range.

extending south from the steeper slopes of South Mountain and having an average elevation of 1,000 feet. Slopes range from 20 to 60 percent. Erosion is a serious problem due to ^{primarily} clean cultivated cropping ^{and overgrazing} on excessively steep slopes.

3. Somis Mesa. A gently sloping bench-like upland ranging from 400 to 600 feet in elevation which occurs most prominently north and east of Somis although well defined as far west as the Milligan barranca. Slopes average from 5 percent along the southern margin, which is approximately 100 feet above the valley floor, to 20 percent along the northern portion which merges into the foothill region without any perceptible change in grade.

Figure 2. Partial panorama of the Las Pintas area looking north from the summit of the Geronimo Hills. In the background is the South Mountain Range.

extending south from the steeper slopes of South Mountain and having an average elevation of 1,000 feet. Slopes range from 30 to 50 percent. Erosion is a serious problem due to clean cultivated cropping on excessively steep slopes.

3. Santa Mesa. A gently sloping bench-like upland ranging from 400 to 600 feet in elevation which occurs most prominently north and east of Santa Mesa although well defined as far west as the Milliken barrens. Slopes average from 5 percent along the southern margin, which is approximately 100 feet above the valley floor, to 20 percent along the northern portion which merges into the foothill region without any perceptible change in grade.

Sheet and gully erosion are both serious problems.

4. Valley ^{Floor} Lowland. The valley ^{floor} ~~Lowland~~ or Las Posas lowland includes that part of the Las Posas valley lying between the foothills and Somis Mesa units to the north and the Camarillo Hills to the south, as well as a portion of the Oxnard plain in the general vicinity of Camarillo. The Las Posas valley widens west of Somis where an alluvial fan spreads out over the valley forming a slightly elevated crown which divides drainage between Arroyo Las Posas to the east and the Las Posas Wash to the west.

Sheet erosion is not a serious problem. There is considerable damage done, however, through side cutting along the main entrenched barrancas and from deposition of debris washed out of the Camarillo Hills, *South Mountain Range, Foothill Region and Somis Mesa.*

5. Camarillo Hills. A roughly ovate dome-shaped group of hills extending east from the western project boundary to Somis. This unit divides drainage between the Las Posas Valley to the north and Oxnard Plain to the south.

Both gully and sheet erosion are highly accelerated and there is also considerable damage resulting from deposition of infertile overwash along the margins of the hills.

6. Las Posas Hills. Similar in topography to the Camarillo Hills and lying in a direct line with them beyond the alluvial fan of the Las Posas Lowland, this section rises gradually from the east bank of the Arroyo Las Posas to an elevation of 1000 feet. The crest line forms part of the eastern and southern boundaries of the project.

Gullies are numerous and sheet erosion is relatively severe.

Drainage

The contiguous units comprising South Mountain, the foothill region, Somis mesa and the Las Posas lowland are drained by a series of gorge-like barrancas (Fig. 4) with depths exceeding 75 feet and



Figure 4. Typical drainage-way barranca.

widths 200 feet. These drainage ways originate in the foothill section and traverse southwesterly through mesa and valley lowland to join either the Arroyo Las Posas or the Las Posas Wash. The former receives the discharge from the Lagol, Mahan, Puerto ^aZuela, Camino and Fox barrancas; (Fig. 3) the latter from the Honda, Colorados and Milligan barrancas.

Both the Camarillo and Las Posas Hills are drained by a network of small barrancas, ~~dissections~~. Discharge from the north slope of the

The continuous units comprising South Mountain, the foothill region, Santa mesa and the Las Posas lowland are drained by a series of finger-like barrancas (Fig. 4) with depths exceeding 75 feet and

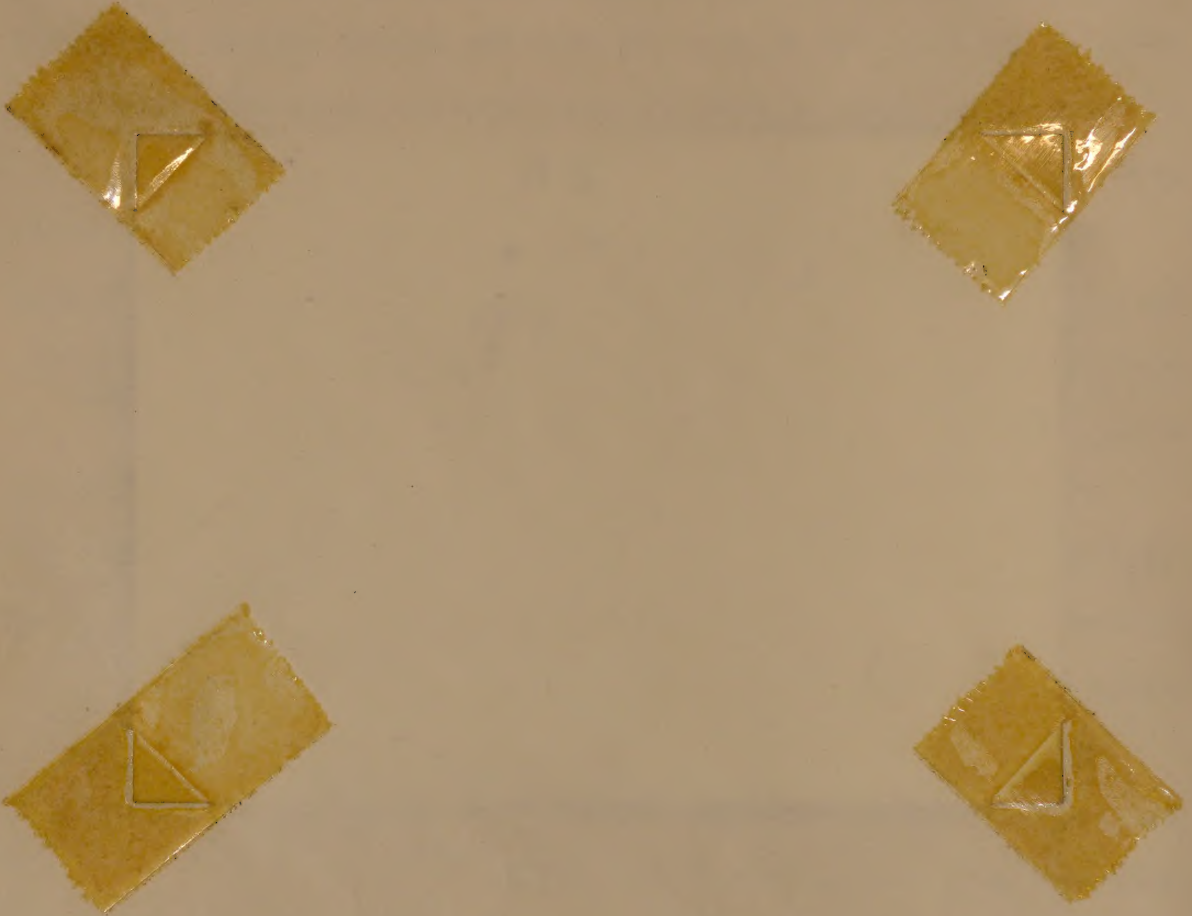


Figure 4. Typical drainage-way barranca.

within 300 feet. These drainage ways originate in the foothill section and traverse southeasterly through mesa and valley lowland to join either the Arroyo Las Posas or the Las Posas Wash. The former receives the discharge from the Larami, Mahan, Puerto Santa, Camino and Fox barrancas; (Fig. 5) the latter from the Honda, Colorado and Milligan barrancas. Both the Camarillo and Las Posas Hills are drained by a network of small barrancas. Discharge from the north slope of the

Camarillo Hills spreads and disappears on the Las Posas Lowland that from the south slope on the Oxnard Plains. The drainage from the Las Posas Hills flows directly into the Arroyo Las Posas.

All of the drainage ways are intermittent streams flowing only during and immediately after storms.

Geology

Although the geology of the Las Posas ^{area} presents a variety of complicated technical problems, it is possible to reduce this complex to a relatively simple discussion as related to soil and erosion problems. ^{Gabbert states that} there are four major groups of geologic materials or formations differentiated on the basis of similar physical characteristics. These are the Modelo and Pico Shales, Saugus sands, and terrace deposits. The significant features and occurrence of each of these units are as follows:

Modelo Shale. Occurs on South Mountain where the white, relatively hard platy-like strata^a are quite conspicuous at the heads of the foothill valleys. These exposures are almost devoid of soils or vegetation and form roof-like areas which are conducive to abnormally high runoff. (Fig. 5) The soils on the more rounded slopes are medium to heavy textured and support a good cover of grass and brush. Flagstone rock from the Modelo formation has been used quite extensively in the Las Posas in the construction of rock masonry erosion control structures by CCC enrollees.

Pico Shale. The Pico formation, occupying the upper foothill region consists largely of thinly bedded shales having a high clay content which makes this entire area susceptible to sloughing. The relief reflects numerous evidences of old land slips, some of which

(5) Gabbert, Howard M. Geopedologic survey of the Arroyo Las Posas Demonstration Project, Ventura, California. U. S. Soil Conservation Service (Unpublished; on file Regional Office, Berkeley, California) 1935.



Figure 5. Modelo Shale formation in the background. High runoff is general in these areas. Note clean cultivated bean field on slope above.

never healed and later grew into gullies. The sediments are rather uniform throughout and give rise to silty clay and clay loam soils which support a predominating grass cover.

Saugus Formation. This unit characterizes the lower more generally cultivated portion of the Foothill Region, and the Camarillo and Las Posas Hills. The sediments are essentially rather loosely consolidated sands and coarse gravels with interbedded shales and clays. The associated light textured soils support a sagebrush cover and are highly erodible, being particularly susceptible to deep hill-side gullying. The Saugus formation is particularly significant from

the standpoint of ground water. The same strata that outcrop along the foothills, dip beneath the valley floor where the gravel beds are waterbearing and provide an important source of valley irrigation water.

Terrace Deposits. The terrace sediments are coincident with the Somis Mesa and flank portions of the lower Camarillo and Las Posas Hills. They comprise a mixture of old weathered sands and gritty clays, characterized by a somewhat reddish brown color. The soils are generally cultivated and have well developed relatively impermeable subsoils. They are extremely erodible and constitute the major "problem soils" in the project area.

Climate ←

*U.S. Weather Bureau?
Citation!*

The climate of the Las Posas area is similar to that of other coast sections in Southern California. The year is divided into a wet and dry season corresponding to winter and summer, respectively.

The rainy period extends from late October or November to the early part of April. Maximum precipitation occurs during the three winter months in which, on the average, 60 percent of the mean annual rainfall is received. Storms of several days duration commonly experienced during this period cause severe erosion damage. It is not unusual for as much as one-fifth the entire year's rainfall to be precipitated in a single storm.

The late spring, summer and early fall are practically arid, the rainfall being seldom sufficient to more than dampen the surface of the ground. The summer climate is greatly influenced by damp, cool ocean air and fogs which have an important bearing on the production of dry farmed crops, inasmuch as high humidity materially reduces

soil moisture losses by evaporation and plant transpiration.

The average annual precipitation at Somis, in the southeastern part of the area, from 1892 to 1938 inclusive was 14 inches. In this 47 year period, 22 years were below normal and 24 years above normal. The highest rainfall was received in 1909 when 28.27 inches fell and the lowest in 1898 when 4.08 inches fell. The year 1938, with 24.7 inches, was the second heaviest of record and provided an exceptionally severe test of soil conservation installations.

The temperature varies considerably in different parts of the area and is noticeably influenced by topography, wind movements and exposure. The southern and western portions are perceptibly cooler in summer and warmer in winter, due to the modifying influences of ocean breezes, than are the protected inland valleys. Upland areas suffer the least extremes in temperature, and are preferred for the culture of subtropical fruits. Killing frost of occasional occurrence are confined to the period between November 15 to March 20. These rarely affect the upland sections where air drainage is excellent.

Prevailing winds are from the west. At times, particularly during late summer, fall and early winter desiccating and frequently high velocity east winds occur which sometimes result in serious losses to growing crops.

Table 1 gives the climatological data for Somis, in the southeastern part of the project area.

Table 1. Monthly, seasonal and annual temperature (1) and precipitation (2)
at Somis, Ventura County, California
(Elevation 288 feet)

Month and Season	Temperature		Precipitation	
	Mean	Mean	Total for the driest year (1898)	Total for the wettest year (1909)
			Inches	Inches
December-----	54	2.26	.18	8.19
January-----	54	3.25	.87	9.21
February-----	55	2.94	.57	4.71
Winter-----	54	8.45	1.62	22.11
March-----	57	2.47	.51	4.11
April-----	58	.78	.07	--
May-----	61	.40	1.05	--
Spring-----	59	3.65	1.63	4.11
June-----	63	.05	--	--
July-----	67	--	--	--
August-----	67	.01	--	--
Summer-----	66	.06	--	--
September-----	66	.23	.75	--
October-----	64	.60	.08	.49
November-----	61	1.01	--	1.56
Fall-----	64	1.84	.83	2.05
Year-----	61	14.00	4.08	28.27

U. S. Weather Bureau and others.

(1) Estimated from surrounding stations, 22 year average record.

(2) 46 year record, 1893-1938, *F. A. Snyder Ranch, Somis, California*

Native Vegetation.

The native vegetation of the area is essentially a sagebrush type. (Fig. 6). It is dominated by coast sagebrush (Artemisia calif-



Figure 6. Native sagebrush cover protecting hillside land.

ornica), purple sage (Salvia leucophylla), and black sage (Salvia mellifera). Important associated species are leomanade berry (Rhus integrifolia), wild buckwheat (Eriogonum fasciculatum), deerweed (Lotus scoparius), coyote brush (Baccharis pilularis), prickly pear (Opuntia sp), Yucca (Yucca whipplei), California giant rye-grass (Elymus condensatus), stipa bunchgrass (Stipa pulchra), Melic grasses (Melica sp), and wild f^escues (Festuca sp). The density and percentage of the associates vary considerably with site and give rise to

Native Vegetation.

The native vegetation of the area is essentially a sagebrush type. (Fig. 3). It is dominated by coast sagebrush (*Artemisia calif-*

Figure 3. Native sagebrush cover protecting hillside land.

ornica), purple sage (*Salvia leucophylla*), and black sage (*Salvia melitensis*). Important associated species are leonardo berry (*Rhus integrifolia*), wild buckwheat (*Eriogonum fasciculatum*), goosewood (*Quercus agrifolia*), coyote brush (*Baccharis pilularis*), prickly pear (*Cylindropuntia*), Yucca (*Yucca whipplei*), California giant reed-grass (*Elymus canadensis*), ridge bunchgrass (*Stipa pulchra*), Mole grass (*Helictes* sp.), and wild Yucca (*Yucca* sp.). The density and percent-
age of the associates vary considerably with size and give rise to

several subtypes such as the Lotus and Stipa.

Originally the native vegetation consisted very largely of two main types, namely, sagebrush (and associates) and grass. The grass is believed to have covered not only the valley floor, but also a fair part of the present sagebrush-type area. The balance of factors that allowed the grass to dominate the brush on many slopes was apparently very delicate and grazing in the early days seems to have upset the balance by heavier pressure on the more palatable grasses, so that the less palatable brushy species were able to advance.

In and along lower courses of drainage ways, willow (Salix sp.), water m²ot²fy (Baccharis sp.), tobacco tree (Nicotiana glauca) and saltbush (Atriplex ^bBreweri) are predominant. As the foothills are approached this vegetation gradually merges into sagebrush.

In several isolated canyons of the foothills, coast live oak (Quercus agrifolia) and bluegrass (Poa sp.) form an interesting association which apparently represents the remnants of an older climax type.

Fields recently retired from cultivation and burned-over areas support a number of annuals, those of importance being wild oats (Avena fatua), mustard (Brassica nigra), red brome (Bromus rubens), ripgut grass (Bromus rigidus), alfileria (Erodium cicutarium), and bur clover (Medicago hispida), all of which are introduced species. These share with other species intermediate stages in succession to the climax sagebrush type.

Blue and red gum trees (Eucalyptus globulus, Eucalyptus rostrata), introduced some 30 years ago for windbreaks, form important stands in scattered locations throughout the area.

Some of the other common grasses and legumes which are widespread in the native cover are June grass (Koeleria cristata), smilo grass (Oryzopsis mileacea), western rye grass (Elymus glaucus), and several native clovers (Trifolium sp.), and lupines (Lupinus sp.).

Wildlife

~~It is reported that~~ When the settlers first came to this state, wildlife was so abundant in many parts as to be simply beyond the powers of realization by the people of our time. Except for a few species, there is probably not a native bird or mammal as numerous in the state today as it was in 1839. Several birds have become entirely extinct and many are enormously reduced in numbers and much restricted in range.

Unfortunately there are no definite data to show whether wildlife has diminished or increased following white man's occupancy of the Las Posas area. However, a comparison of the type of cover then and now and a review of the very meager records and reports do indicate that, in general, there are fewer wildlife species and numbers than formerly.

The greatest reduction has occurred among the water-fowl, upland game birds, birds of prey, game and predatory mammals. Perching birds, rodents and rabbits have suffered least. A few wildlife species such as the California ground squirrel are considered injurious to agriculture. Their numbers are kept down by control operations conducted by farmers and governmental agencies.

Due to the complete drainage of all marshes and other water areas, water fowl, except for an occasional visitor, have completely disappeared from the project area and immediate vicinity. It may be assumed that herons, egrets, rails, coots, ducks and geese were originally present in numbers comparable to those in other similar regions. Geese were reported ⁽⁶⁾ to have been so numerous at times that it was necessary to patrol the grain fields on horses to protect the crops.

Except for the turkey buzzard, which is holding its own, the
*(6) Statements to the author (1939) by James Donlon and
Herbert E. Guthrie early settlers in the Las Posas area.*

other diurnal birds of prey (order Falconiformes) are greatly reduced in number. The great California condor, the largest bird in North America, is now rarely observed in this part of Ventura County. The hawks and eagles are known to have been greatly reduced and some, as for example the white-tailed kite, are very rare.

Clearing ^{the land} of brush and grass cover, the single cropping of beans, and the pressure of hunting are important factors in reduction of quail. Morning doves have also suffered from similar causes. There has probably been little change in the numbers of band-tailed pigeons, since it is doubtful that they were ever plentiful in this section.

Of the perching birds (order Passeriformes) there were natural fluctuations in numbers from year to year. Members of this order are the sparrows, finches, blackbirds, orioles, thrashers, wrens, warblers, larks and others, which live chiefly on insects and weed seeds and are generally beneficial to agriculture. In general, populations are about the same or slightly greater than were originally found.

Economic and Social Conditions

The total population of the project area is approximately 2,000. It is comprised chiefly of native white Americans of British and German descent. A large group of foreign born Mexicans employed as farm laborers ^{is} ~~are~~ also present. ~~About 40 percent of the entire population, representing tenants and farm laborers, average not more than five years residency, an important factor influencing permanency of conservation practices.~~

Somis with a population of approximately 250 is the only town within the area. It is of local importance and shares the trade and shipping of the area with the adjacent towns of Moorpark, Camarillo,

and Saticoy and the nearby cities of Oxnard and Ventura.

The area is exclusively agricultural, farming being the major industry. Livestock production, including sheep and cattle raising, is of minor importance. These provide employment for all of the adult male population. Omitting the considerable number of itinerants hired during the harvest season, the annual labor load per farm averages 2.5 man years. Wages are relatively high, experienced farm hands receiving \$65 to \$70 per month, including board and lodging.

The project area is subdivided into 592 properties. Of these, 312 are suburban residential homesites of less than 3 acres. The remaining 280 properties are farms embracing a total of 37,490 acres.

The majority of the farms are individually owned. However, corporations including banks hold 17 percent of the total number and 29 percent of the total farm acreage (Table 2). One large investment corporation alone owns 33 farms, comprising 7,398 acres or 19 percent of the land in farms on the area.

Table 2. Farms and acreage by type of ownership(1)

Type of Ownership	Number of Farms	%	Total Acres	%
Corporation	39	14	8034	22
Bank	9	3	2721	7
Individual	232	83	26735	71
	280	100	37490	100

(1) Assessors records, Ventura County.

Although individual owners operate 54 percent of the total number of farms on the project the larger size of tenant operated units makes this group the most important with respect to acreage farmed; owners and managers following in the order named. Table 3 classifies farms and farm acreage according to ownership and operator and shows the relative status of each group.

Table 3. Farm classified according to type of owners and operators

Type of Operator	Type of Owner								Total all Owners			
	Corporation and Bank				Individual							
	Number of Farms	%	Acres	%	Number of Farms	%	Acres	%	Number of Farms	%	Acres	%
Owner					150	65	10699	40	150	54	10699	28
Tenant	18	38	5433	51	61	26	11349	42	79	28	16782	45
Manager	30	62	5322	49	21	9	4687	18	51	18	10009	27
Total	48	100	10755	100	232	100	26735	100	280	100	37490	100

The average size of farms is 134 acres (Schedule 1)*. Only 11 farms are over 500 acres and 3 farms over 1,000 acres, the largest being 1261 acres. Tenant and manager operated farms are from two to three times larger than owner operated units.

Land values vary considerably with type of utilization. (Table 4).

Table 4. Type of land utilization and approximate range in ^{price}value per acre

Land Utilization	Value per Acre
Beans	\$50. - \$ 600.
Walnuts (mature)	\$750. - 1500.
Citrus (mature)	\$750. - 3000.
Hay and grain	\$40. - 150.
Pasture	\$10. - 50.

The range in value of each type of usage is also marked pointing to the variability of site conditions throughout the area. Farms are largely unencumbered, surveys indicating that only about 30 percent carry mortgages. Bank holdings, however, represent acquisitions through foreclosure on mortgages in the past decade.

The area as a whole is highly improved. Transportation facilities are excellent. A network of macadam and concrete surfaced roads gives ready access to all parts of the project area and through connecting highways brings other parts of the county within easy reach. United

* See appendix

States Highway 101 runs parallel to southern boundary of the project. California State Highway 118 passes in an east-west direction through the center of the project. The main coast line of the Southern Pacific Railroad traverses the north-eastern portion of the area and follows its eastern boundary beyond Somis station to Camarillo.

Rural mail service and telephone lines bring communication to practically every farm home. Although only two grammar schools and one church are located in the area splendid educational, religious and recreational facilities are provided in towns and cities at no great distance from the project. School busses transport children to and from school, covering as much as 40 miles in the trip. It is estimated that 80 percent of the ^{white} children finish high school and 25 percent finish college.

Residences of farm owners and managers are generally substantial and well kept, while those of tenants are of mediocre character. Excepting in a few isolated canyon locations, homes have all the conveniences of modern city dwellings; including electricity, water systems, radios, washing machines and other modern household appliances. Farms are well equipped with late designed farm machinery, tractors, trucks and automobiles.

Profitable crop production has made many of the farmers independently wealthy, especially those operating lowland and mesa land farms. The majority of the farmers are well educated and have a very high standard of living.

Farm income is derived almost entirely from beans, walnuts and citrus crops. Markets for these products are international in character; their sales being handled through brokers and cooperative or mutual marketing associations. The latter are particularly strong, the relative imperishableness of the crops and ample storage facilities

in centralized warehouses providing an incentive for cooperation in securing advantageous markets. It is estimated that 50 percent of the beans, 95 percent of the walnuts and all of the citrus are marketed through association channels.

LAND UTILIZATION AND DEVELOPMENT.

A review of the development of the project area lands will aid materially in identifying contributory sources and causes of soil erosion. Moreover, the scope and character of the problems encountered by the Soil Conservation Service will be more fully appreciated.

Three periods are to be noted in the history of land-use of project area lands:

- (1) Aboriginal Period
- (2) Spanish-Mexican Period
- (3) American Period.

Aboriginal Period.

Before the appearance of the white man little occupation or agricultural usage of area lands has been recorded or is evident. The aborigines of this section lived in small villages, ~~or "rancherios"~~, along the coast gaining their livelihood primarily by fishing. ⁽⁷⁾ This coastal concentration of the primitive population dependent upon Nature's resources for subsistence was especially favored by the richness and abundance^e of the marine life along the shores of the Pacific. Relics of arrowheads indicate, however, that area lands were used as hunting grounds by the local tribes to obtain deer, bear, and other wildlife which were plentiful in those early days.

The Indian influence, while not directly affecting the problems
(7) Kroeber, A. L. Handbook of the Indians of California. Smithsonian Institution Bureau of American Ethnology. Bul. 78. 1925.

later to be developed on the Las Posas area, cannot be entirely disregarded. Their labor, perhaps unwilling at times, supplied the needed man power for agricultural developments initiated by the Missions in the succeeding period.

Spanish-Mexican Period.

Although as early as 1542 Spain had laid claim to California by right of Cabrillo's exploratory voyage along the Coast, actual occupation and settlement were delayed for more than two centuries. In the years following 1769, Spain, prompted primarily by the threat of Russian penetration, rapidly extended her Mexican domain northward in order to secure claims established through priority of discovery. Meeting with little resistance from a rather peaceful and primitive aboriginal population, the conquest of California was soon completed. Identified with the conquest and early settlement was the Catholic Franciscan Order to whom had been granted the exclusive guardianship of the Indian population and their lands. Under the leadership of the famous Padre Junipero Serra and with the assistance of local Indian converts, the Franciscan Order established Missions in various centers of Indian concentrations throughout ~~what is now~~ Coastal California ^{and} *as far north as Sonoma County.*

The establishment of the Missions ended the period of primitive land-use, which had done little to disturb the virgin character of the soil and its vegetation, and ushered in a period of agricultural exploration and development which did much to influence the future evolution of agriculture throughout the state. Possibly the most important contribution of the Missions was the introduction and demonstration of the adaptability of livestock and crops which could be

successfully produced in the various sections of California in which the Missions were located. Many of the crops now produced in this section stem from the early investigations of the Mission Padres at the Mission San Buenaventura, which had been founded in 1783[^] upon a site which now constitutes a part of the city of Ventura. *and still stands*

The explorer, Vancouver, visiting the Mission San Buenaventura in the early part of the 19th Century, remarked(8) on the quality, quantity and variety of the production of its gardens: "Not one species has yet been sown or planted that has not flourished and yielded its fruit in abundance of excellent quality. These have principally consisted of apples, pears, plums, figs, oranges, grapes, peaches and pomegranates together with the plantan banana, coconut, sugar cane, indigo and a great variety of the necessary and useful herbs, kitchen plants and roots."

The wealth of the Missions accumulated rapidly in a land where climate and virgin resources of soil and vegetation were so favorable for the support of crops and livestock. In 1825, less than a half century after its establishment, the Mission San Buenaventura recorded ownership of 37,000 cattle, 600 horses, 200 yoke of working oxen, 500 mules, 30,000 sheep and 2,000 goats valued at about \$250,000. In addition, considerable acreage in the vicinity of the Mission was devoted to the production of wheat, maize, barley, frijoles (small Spanish bean) and other truck crops. When it is considered that the initial inventory of the Missions consisted of only a few head of livestock, small quantities of seeds, plants and young trees and crude tools, implements and machinery brought from Mexico and Spain, the inherent richness of the resources of this new land is more fully

(8) Forbes, Alexander. California: A History of Upper and Lower California. Smith, Elder Company. London 1839. Reprinted by John Henry Nash, San Francisco, 1937.

appreciated.

Although the Mission San Buenaventura had jurisdiction over the lands now included in the project area, evidence of actual usage of the land during that period is uncertain.

Under the Spanish regime most of the virgin territory of California was under the control of the missions. Some large land grants, however, had been made by the Spanish Crown to selected individuals who had been instrumental in the conquest of California. Following the revolution and the establishment of independent Mexico in 1822 the new government, looking for sources of revenue, regarded the wealth of the missions enviously and began to secularize them in 1833. ~~This~~ ^{program} ~~depeeling of the missions~~ not only marked the decline of their system of agriculture but was also disastrous to the Indian population which had become dependent on them for its livelihood and support.

In the records of the San Buenaventura Mission an Indian population of about 700 was in existence in 1832. Three decades later, when the Americans came to occupy this section, there were but a few scattered peons to be found on the ranchos as remnants of the once important aboriginal population.

As a means of securing more tax revenues the Mexican Government, following the Decree of Secularization, disposed of the lands of the missions and other valuable agricultural land throughout California in tremendous acreages to favored grantees and influential settlers.

Included among these grants ^{were those} ~~was that~~ of the Las Posas Rancho and the Rancho ~~El Rio de~~ Santa Clara del Norte, the former made to Don Jose Antonio Carillo in 1834 and the latter to Juan Sanchez in 1837. The Las Posas Rancho comprised 26,623 acres and that of the Santa Clara del Norte 13,998 acres. The project area, named from the Las Posas Rancho, includes all of the original Las Posas Grant and part of that

of the Santa Clara del Norte, as well as certain other lands not originally separated by Mexican Grants.

The early owners were principally interested in cattle, being influenced by the success of the Mission and the ease of conducting the enterprise. Following the discovery of gold in California in 1849, so great a demand for meat was created that beef delivered on the hoof at the mines in northern California brought as high as a hundred dollars per head⁽⁹⁾. The cattle industry expanded rapidly under this pressure. The Assessment Roll of 1858 showed nearly one million head of cattle in the state. In 1862, the year in which cattle prices hit their low of two cents a pound, there were more than one hundred thousand head in Santa Barbara County⁽¹⁰⁾ alone. The fact that cattle from Santa Barbara County had to be driven many hundreds of miles in order to be marketed was a disadvantage. As a result, about a hundred thousand head were slaughtered in the county in an effort to remove the depression in the market. This disposition of cattle helped to relieve the situation, but the natural increases of herds would have replaced the slaughtered animals had not the drouth of 1863-64 almost destroyed the entire industry. Following the slaughter and drouth less than five thousand head of cattle remained in the county. Spanish ranch owners, who were noted for their *easy-going nature* ^{proficiency}, saved little, and when the crash came, with herds gone and properties mortgaged, many of the large land holdings were acquired by American interests or subdivided and sold to settlers who had come into California following American conquest in 1848 and the admittance of California to statehood in ¹⁸⁵⁰ ~~1858~~.

¹⁰ (4) Ventura County, in which the Las Posas project is located, was included within Santa Barbara County until 1873.

(9) Gidney, C. M., Brooks, Benjamin and Sheridan, Edwin M. History of Santa Barbara, San Luis Obispo and Ventura Counties, California. Lewis Publishing Co., Chicago. 486 pp. illus. 1917.

American Period.

The great drouth of 1863-64 closed the period of Spanish domination in California and the succeeding years witnessed the injection of American enterprise into the agricultural development of this vast area. The discovery of oil in Santa Barbara County shortly before the end of the Civil War started a land boom in this section. Coming after the conditions which had left the Spanish cattle owners in precarious circumstances, speculators readily purchased large tracts of land. Thomas Scott, Assistant Secretary of War in Lincoln's Cabinet and later President of the Pennsylvania railroad, operating through the California and Philadelphia Petroleum Company, acquired some 200,000 acres in what is now Ventura County. Included in this immense purchase was the Las Posas Rancho, ^{(11).} ~~which~~ ^{This rancho,} together with the adjacent ^{a total of} Rancho Simi comprising about 125,000 acres, was sold to the Scott interests in 1867 for \$550,000, or a little more than \$4.00 per acre (12).

The subsequent history of land utilization and development of Las Posas project area lands is primarily a history of the Las Posas Rancho. This passed through three distinct periods of development occurring in the following order:

- (1) Sheep period (1867-1880)
- (2) Grain period (1880-1900)
- (3) Bean period (1900-)

Sheep period (1867-1880).

In 1865, Thomas Bard arrived in California to take charge of the active management of the vast Scott interests. Bard, with the influence commanded by the resources of eastern capital coupled with a keen and discerning judgment, quickly assumed an important role in the development of industry and agriculture in this section.

The expectations of oil, although later realized on some of the

Scott holdings, proved unpromising on the Las Posas. The drouth of 1863-64, which almost wiped out the cattle industry, coupled with the agitation for legislation designed to make ^{cattlemen} ~~ranchers~~ instead of farmers fence in their land proved favorable for the sheepmen, since large bands could be easily handled by a shepherd with the assistance of sheep dogs. The rapidity of annual increase of sheep, high yields of wool, good prices, and ample range provided an impetus to sheep production which resulted in steady expansion of the industry. Bard, realizing the profits to be gained for his associates, entered the sheep business in 1867 using the lands of the Las Posas Rancho for grazing.

Sheep were herded in large bands of from 1,000 to 5,000 head. No particular management practices were followed, the sheep ranging wherever vegetation afforded ample feed. This consisted principally of wild oats (*Avena barbata*), alfileria (*Erodium cicutarium*), bur clover (*Medicago hispida*), and bunch grasses represented by *Melica*, *Stipa* and *Elymus* species, ^{and browse plants of sagebrush type.} The oats, alfileria and clover were introduced species having been brought into this section with the Mission enterprises of the earlier Spanish period. The bur clover was of special importance, yielding a quality of dry feed unsurpassed by other types of vegetation. This was of significance to the economics of the sheep business since other types of vegetation became unpalatable during the eight practically rainless summer and fall months.

Time in 1867?
Source?
How about browse?

During the winter rainy months, when water was not an important factor, sheep were pastured along the foothills and in the mountainous sections of the area, which in those days were covered with considerable more grass and less brush than at present. In the summer, when the feed and land were dry and the water was limited, the bands were moved to the valley lands in the vicinity of Somis, then marked by a single dwelling, an adobe built sometime in the early 40's by the Spanish

ranch owners. This dwelling as late as 1870 was the only one in the entire Las Posas. Located close by were several natural springs flowing throughout the entire year. In 1875, at this site, a well was dug yielding an artesian flow of water. More than a half a century later this site was to provide the main source for wells supplying irrigation water to the lands of the project area.

By 1875, it was estimated that more than one million sheep were on pasture in Ventura County, which had been separated from Santa Barbara County at the close of 1872. At least 15,000 sheep were known to have been grazed annually on Las Posas lands. This rapid increase in sheep also took place in other sections of California. It was the sheep era. In this section the increase was greatly influenced by the construction, in 1872, by the Bard interests, of a wharf at Hueneme providing ocean transportation facilities. This, being a closer outlet than Ventura, served the entire southern section of the county up to the coming of the Southern Pacific railroad in 1898.

Sheep were raised both for mutton and wool, which in the course of time with the increase of sheep population became exceedingly speculative. In 1875 mutton sold at 16 cents per pound live weight. The following spring prices dropped to 5 cents. Fluctuations in wool prices were equally as violent. Panics such as that of 1873 and variations in prices, although markedly influencing the profitableness of the business, did not seem to hit the industry severely. Drouths were worse than panics and price fluctuations. The one in the ^{season} ~~winter~~ of 1876-77 in this section was as catastrophic for the sheep industry as that experienced by the cattle industry in the previous decade. Bankruptcy and loss of land were prevalent with much of the wealth of the early settlers being swept away. The sheep industry never regained the status it previously held on the Las Posas lands. However, con-

rench owners. This dwelling as late as 1880 was the only one in the entire Las Posas. Located close by were several natural springs flowing throughout the entire year. In 1875, at this site, a well was dug yielding an increased flow of water. More than a half a century later this site was to provide the main source for wells supplying irrigation water to the lands of the project area.

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siderable pasturage was provided until as late as 1884. Since then a limited number, never exceeding 1,000, have been pastured during the late winter and early spring on the South Mountain area.

Grain period (1880-1900)

The hazards of the sheep business coupled with an increasing influx of settlers and their insistent demand for farm lands exerted a rapid change in land use throughout this section. Notwithstanding the financial blow dealt the Scott-Bard interests ^{by} the drouth of 1876-77, the Las Posas Rancho remained intact. Coincident with the loss of revenue occasioned by the decline of the sheep industry a large area of the Las Posas lands was diverted to the production of wheat, barley and corn which, since their first introduction by the Mission, had been grown in various parts of the county.

As early as 1872 small acreages of wheat were being grown ~~on in~~ ^{section.} the Las Posas. [^] Following the severe drouth in that decade a rapid extension of grain farming occurred. At first this was principally wheat, which was grown on the mesa and rolling hill lands of the southern part of the Las Posas. (~~Presumably these particular sites were first selected because they were well drained and frost free.~~) Later with the introduction of barley and corn, grain farming extended to the valley lands. ~~By 1890 about 16,000 acres on the project were in production.~~

Indicative of the importance and growth of the grain industry are the statistics of exports from the port of Hueneme through which the production of the Las Posas Rancho passed (Table 5).

Table 5. Comparisons of exports of barley, wheat and corn from Port of Hueneme, 1880 and 1888

	Year	
	1880	1888
	(100# sacks)	(100# sacks)
Barley -----	232,095	508,111
Wheat -----	21,479	16,073
Corn -----	16,888	12,534

Both wheat and barley were winter grown, being harvested in mid or late summer. Cultural practices for seeding were very similar to those now used in the production of cereal hay in this section. Land preparation and seeding were usually conducted after the first early seasonal winter rains of October or November although much of the land was prepared and seeded dry earlier in the fall to take advantage of these first rains. Land preparation consisted of shallow plowing, not more than three inches in depth. Seeding was accomplished by the use of a broadcasting ~~endgate~~ seeder attached to a wagon pulled by a team of horses or mules. Following seeding, the land was lightly harrowed. *In some instances,* ~~When dry planting,~~ a hopper seeder was attached to the front of the plow so that seeding and plowing were accomplished simultaneously. Horses and mules were the sole field power, a usual team being six to ten for plowing, the numbers used depending on whether the soil was moist or dry.

Harvesting operations were conducted in a manner somewhat similar to those used in harvesting lima beans at the present time. Due to the tendency of the then used varieties of grain to lodge and shatter on maturity, it was headed while still green and dumped into small piles to dry. Later, it was forked into large wagons and transported to a stationary steam-powered threshing machine. The large straw piles were usually burned or sometimes scattered over the fields of

stubble which were rented for sheep pasture. In the event that the stubble was not sheeped-off, it was burned - since, with the tillage implements and field power then available, the thick mat of stubble interfered with plowing operations.

Corn, of relatively minor importance in comparison to small grains, was produced as a summer crop planted in the late spring after danger of frost was past. A considerable portion of the corn crop was fed to hogs, which had developed into an important enterprise in other sections of the county. Large quantities of shelled corn were also shipped to the mills in San Francisco to be ground for meal.

About 1888 flax, which had been grown for seed successfully elsewhere in the county, was introduced on the Las Posas. Several hundred acres were devoted to its culture for a short time. Notwithstanding reasonably good yields, the inability of producers to obtain favorable markets and prices, coupled with the fact that lima bean production was beginning to prove exceedingly profitable, resulted in cessation of production. That flax was grown in this early period is interesting since the Soil Conservation Service, in endeavoring to establish crop rotation practices for erosion control, reintroduced its culture ^{in 1937.}

Up to 1888 all of the land of the ^{Rancho} Las Posas had been operated either directly under the owners' supervision or under rental agreements in which the owners dictated cropping policies. Since the majority of the area at that time was practically under single ownership, community and social development had progressed slowly. Few permanent dwellings had been constructed, inasmuch as the grain farming type of land use was easily supervised by a small group of residents. For operations such as harvesting, cheap and reliable Chinese labor, which had become plentiful following the completion of the great overland railroad enterprises, was readily available at Ventura and Hueneme.

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Yields of 20 to 30 one-hundred pound sacks of grain, although somewhat reduced from earlier production by continuous cropping, were still satisfactory from a profit standpoint. The fact that the Las Posas was rather isolated and almost inaccessible during the rainy season also hindered settlement. All of these conditions, which were duplicated many times over throughout other sections of California, tended to maintain the economic stability of large ranches. However, the continued influx of settlers, their insistent demand for farm land, ^{and the} resulting ~~in~~ sharp increase in land ^{prices} ~~values~~, and legislation and agitation against cheap Chinese labor pointed toward changes which were to include the gradual dissolution of many of the vast ranches.

In 1888 the Las Posas Land and Water Company was formed to dispose of the holdings of Scott, who had died in 1882. Under the direction of this company, the Las Posas Rancho was subdivided into a number of smaller ranches. Between the years 1888 and 1894, during which this company functioned, the entire ^{Rancho} ~~ranch~~ was sold. Considerable portions were acquired by small independent ranch operators. By far the larger acreage was purchased by investment interests headed by Thomas Bard, totalling about 10,000 acres. Prices ranged from about \$80.00 per acre for the valley lands to \$25.00 per acre for the hills and mesa lands. Although less than 25 years had elapsed since the original purchase from the Spanish grantees, values had increased more than 600 percent on the poorest land.

At the same time these events were occurring on the Las Posas Rancho, the sectionized Government Lands included in the project area, comprising the South Mountain section and southern slopes of the Camarillo Hills, were being homesteaded. The eastern portion of the Rancho ~~El Rio de~~ Santa Clara del Norte, also included within the

project limits, was also being sold off in small ranch parcels of 40 to 200 acres by interests which had acquired the land from the original Spanish heirs about the time Scott purchased the Las Posas Rancho.

At the close of the period the majority of the valley and mesa lands ^{was} ~~were~~ under cultivation, producing crops of barley, wheat and corn. Small acreages were also devoted to dry bean culture, including Blackeye⁽¹³⁾ ~~(5)~~, Lady Washington, a small white variety of the lima bean, and the large lima bean known commercially as the Lewis lima bean named for a contemporary farmer who first introduced it. Sheep and work-stock ranged the hilly and mountainous portions of the project.

The majority of the individual farms were owner-operated. The Bard interests operated under a company organization with direct supervision of holdings delegated to Thomas Bard.

The extensive plantings of grain crops provided exceptionally palatable food for wildlife, especially birds. Wild ducks, geese, doves, and quail were plentiful, providing both sport and food for the early settlers. Deer, wild cats and coyotes ranged the country in considerable numbers, the latter proving a worry to the sheepmen. ~~Most of this indigenous wildlife disappeared~~ ^{was greatly reduced} shortly after the introduction of lima bean culture, clean cultivation practices eliminating their food and habitat.

Bean Period (1900-)

Early History. The extreme changes in land use and the various problems to arise were little envisioned by the early area farmers when about 1890 a few of them began in an experimental way to plant large lima beans (*Phaseolus lunatus*). Beans of various varieties had been raised for local consumption and export ever since their first intro-

(13) Botanically, cowpeas (*Vigna sinensis*)

duction in the early mission days so that bean culture was not a new thing. Production of dry lima beans of the large variety had been exceedingly successful elsewhere in the coastal sections of the county since about 1880. In fact, yields and profits were so exceptional that many of the first bean growers paid for their land in one season. Climatic conditions common to the general coastal area of southern California were especially suitable to dry bean culture. The alternation of wet winters, building up the soil moisture, and dry summers with fairly high humidity in the early part due to coastal fogs followed by a very dry period during the latter part, provided exceptionally advantageous seasonal growing and harvesting conditions. Under these conditions it was inevitable that acreage devoted to lima beans would increase greatly.

By 1905, lima beans had almost entirely replaced grain production on all the lowland and mesa land of the area. Sheep production practically ceased, ^{and} the available pasture land with the exception of precipitous slopes and mountainous parts ^{was} being used for hay production and pasture for work-stock. Production of lima beans was stimulated considerably in 1898 by the completion ^{by} of the Southern Pacific Rail-
road's ^{Company} Coast Line System through a portion of the southeast side of the project and the construction of terminal warehouse and bean re-cleaning facilities at Somis.

Somis, although never attaining the importance of the major trade centers of the county such as Ventura and Hueneme, became the local center for community and social life of the area up to the introduction of good surfaced roads in 1917.

Bean Culture Methods. Bean land has always been intensively cultivated during the winter and spring to keep out weeds, facilitate moisture penetration, and prepare the seed bed. The consequence of

these practices on sloping lands devoted to bean culture has been of fundamental importance in rapidly accelerating erosional processes.

Originally only shallow cultivation was done. Just after the first rains the land was plowed to a depth of four to six inches. Unless a second plowing was needed for weed control, nothing further was done until the latter part of January, when, after the soil had dried, a chisel was used to loosen the surface soil, compacted by previous rains, and to tear up the weeds. ~~A cyclone~~ ^{weed-cutting or cyclone} harrow was then used to break up the clods, pulverize the soil and cut off any weeds that remained. The land was chiseled and cycloned ~~after each succeeding rain, and cycloned several times just~~ ^{several times} before planting to provide the fine mellow surface and compact lower soil needed for a seed bed.

In 1898 a sugar refinery was completed at Oxnard, and between 1900 and 1906 a considerable portion of the valley land of the Las Posas was leased for sugar beet production. The deep tillage methods ^{of beet cult} introduced to secure maximum penetration of rainfall on the dry-farmed ~~beet~~ land were gradually adapted to bean culture. Both the deep plowing in the fall and the harvesting with a lifting plow, that cut off the roots at depths varying from 15 to 24 inches ~~and lifting them to the surface~~, were moisture-conserving practices. The latter operation, literally subsoiling, left the soil in an open cloddy condition to a much greater depth than had the shallow cultivation which was formerly done.

As beans were rotated with beets, the value of deep cultivation in bean culture was soon realized. Although the rotation produced yields of as high as 26 tons of beets of 20 percent sugar content, bean yields were gradually decreased, ~~presumably due to the effect of the beets~~. Beet growing, being less profitable, was therefore dropped in favor of continuous beans, but the deep cultivation practice was

retained. The beet lifter was changed and adapted to the purpose of subsoiling, while the plows and chisels were also adapted to the requirements of deeper tillage. The increased penetration of soil moisture obtained through these practices greatly influenced the expansion of lima bean culture on dry-farmed land and suggested the possibility of using the steeply sloping hills.

In time, subsoiling and deep plowing became general practices in soil preparation, the former operation being used on heavier soils where the subsoil tended to become consolidated and impervious in the course of summer cultivation. The change in implements was also followed by a change in time at which the practices were conducted. Subsoiling or deep plowing now followed directly after the bean harvest and prior to the first fall rains.

This change to deeper tillage practices necessitated the use of additional implements and operations to prepare the seed bed required for lima beans (Fig. 7). On heavier soils, large clods broken out in the course of deep dry tilling were worked down and pulverized, in late winter when sufficiently moist to crumble, by a "Swede" harrow or clod masher. This operation was followed by the chisel, spring tooth, and cyclone, the latter three implements being used successively following storms of late winter and early spring. On lighter texture soils these operations were identical except ^{that} the clod masher was not required. All land was cycloned at intervals of seven to ten days during the last three weeks prior to planting. In general, the present schedule for soil and seed bed preparation on land lying on slopes below 15 percent is identical to those described.

Planting has varied little from the original methods practiced, being done during the latter part of April or early days of May. The seed is drilled in rows 28 to 36 inches apart, seeds being 5 to 12



A



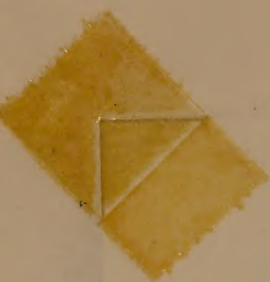
B

C

Figure 7. Four important implements for soil and seed bed preparation on lima bean land. A, subsoiler; B, "Swede" harrow or clod masher; C, cyclone; D, chisel (see following page).

Figure 1. Four important landmarks for roll and each roll orientation
on line beam land. A, subroller; B, "bridge" barrow or also washer;
C, cyclone; D, chisel (see following page).





inches apart in the row. The depth of planting is regulated by the level of moisture, the seed being placed in contact with moist soil which may be from ³ to ⁶ inches below the ground surface. Both four and eight row drills are now used, the former on steeply sloping land (Fig. 8), the latter on more level fields.

Figure 8. Planting lima beans on hillside land.

In the earlier stages of bean production, 45 to 60 pounds of beans sufficed to plant an acre. Continuous cropping for nearly half a century has allowed the disease and insect populations to build up to such an extent that from 80 to 100 pounds of beans are now needed to obtain favorable stands. Continuous cropping has also necessitated additional expenditure for summer cultivation. In the earlier years of lima bean growing a single cultivation or hoeing of the growing

crop was all that was required to eliminate usual weed competition. Today certain typical weeds, such as morning glory (*Convolvulus arvensis*), wire weed (*Polygonum aviculare*), and mallow (*Malva* sp.), the first particularly noxious because of its perennial character, have become associated with the crop, necessitating additional cultivations if satisfactory yields are to be obtained.

The growing crop is cultivated as often as necessary before the plants have spread into the row spaces. Any weeds that come up later are hoed out.

Cultivators are of several types, all with characteristic diagonal or V-shaped knives which are adjustable by levers to run from 1 to 3 inches below the surface of the ground. These not only cut out the weeds, but also tend to compact the lower moist soil through the downward pressure of the knives. On heavier soils particularly this compact layer becomes hard and impervious, necessitating deep tillage in the fall to break it up.

Following the maturity and filling of the bean pods, between August 15 and September 15, the plants are harvested. In the early years harvesting was done by Chinese who pulled the plants by means of a hook attached to the end of a handle. This method was rapidly replaced by cutters drawn by horse power. These cutters shear off the plants from 1 to 3 inches below the surface of the ground, cutting and windrowing two rows in the operation. The plants are then forked into small piles in the windrow to dry, following which they are pitched into wagons and transported to a stationary thresher which separates the beans from the straw, i.e., roots, stems, leaves, and pods.

In the early days threshing operations consisted of moistening and packing down a small area in the field, spreading a deep layer of

cured bean plants over this firmed surface and walking unshod horses pulling light discs back and forth to separate the beans from the pods. This crude operation necessitated expensive recleaning and sorting and was rapidly replaced with mechanical separators, at first adaptations of old barley and wheat threshers, later specially designed machines such as now used.

The large stacks of bean straw, a by-product of threshing, were at first burned. Later, when the straw was determined to have considerable feed value it was baled and stored on the farm or sold for feed. With the expansion of the citrus and walnut industries in the county, beginning in 1890, much of the straw was sold to orchardists for soil improvement purposes. Only in rare cases has the bean farmer incorporated this crop residue in his own fields, *but the practice is now spreading.*

Hill Land Development. Although as early as 1910 small acreages of steeply sloping land were being farmed to beans, the real expansion of hill land culture did not take place until after 1915. Three factors were apparently responsible for this development:

- (1) The application of deep tillage practices on hills so increased interception and penetration of winter rainfall that in seasons of normal precipitation sufficient moisture was stored in the soil to meet the requirements of the summer grown bean crop.
- (2) The decrease in demand for and value of hay and pasture resulting from the replacement of work-stock by power equipment provided an incentive for hill land operators to turn to the production of more profitable crops.
- (3) With the onset of the World War in 1914, increased demand and prices made possible profitable utilization of less favorable sites and soils for the production of lima beans.

Between 1915 and 1920 the majority of acreage of arable hill land of the South Mountain section, Camarillo Hills and contiguous areas, previously farmed to grain and hay crops or used for pasture, were diverted to lima bean production. Even areas of virgin land, brush covered and vegetatively stabilized, with slopes in excess of 50 percent and,

from the standpoint of long time annual crop land usage, unsuitable for clean cultivated crops, were cleared and planted to beans.

Although on the heavier soil types, such as clay loams, with compact subsoils, practices on the hills were the same as those developed on the flat lands, there have been some modifications of practices for the lighter textured soils with pervious or loosely compacted subsoils. On such soils preparation is postponed until a dry period in the middle of the rainy season. At this time of year deep tillage practices are conducted. Chiseling is generally practiced on slopes above 30 percent, the lesser slopes being either subsoiled or plowed. At harvest time the bean piles are sledded down from slopes too steep for wagons.

By the close of 1920 the acreage under cultivation in the Las Posas was much as was found by the Soil Conservation Service at the initiation of its demonstrational program. Although lima beans were the principal crop, considerable acreage on the more drouthy and less fertile hillsides was devoted to the production of Blackeye beans, which are better adapted to the poor sites. In recent years erosion of hillside soils has effected a material increase in Blackeye bean acreage on land formerly used for lima beans. price

Water Development. The economic effects of immediate post war deflation experienced generally by other agricultural sections of the country went almost unnoticed in this section, although agricultural conditions were by no means satisfactory notwithstanding the prevailing high returns from beans. The years 1919, 1920, and 1921 were marked by rather severe drouths which affected the bean crops so adversely as to cause considerable financial difficulty to the farmers in the area.

In 1919, again under the leadership of the Bard interests, investigations were begun on the possibility of securing water in sufficient amounts for irrigation as a means of eliminating the hazards of

dry farming under semi-arid conditions and periodic droughts.

As early as 1875 a well dug near the present town of Somis in the Arroyo Las Posas produced an artesian flow of water which provided the sole dependable source of supply for the livestock, work-stock and domestic use of the early settlers.

In 1888, following the subdivision of the Rancho Las Posas, the water rights to this location were sold to a privately owned company. Additional wells were sunk to supply, by means of pipe lines, a limited amount of water for domestic purposes only to the residences on the valley lands. Outlying ranchers hauled their water, even as they do today, to isolated canyons and hillside farms.

Attempts by individual land owners to secure sufficient quantities of water for irrigation had been tried from time to time with only mediocre success. With water bearing strata from 300 to 600 feet below the surface the few good wells established have been costly to drill and operate. From the standpoint of the individual farmer such wells have been poor investments.

The investigations begun in 1919 resulted in the formation of three water companies by groups mutually interested in the development of irrigation water. Two of these companies obtained drilling rights at the site of the early wells, the third at a location adjacent to the western boundary of the area.

These companies at present supply water for approximately 78 percent, or 12,000 acres, of an average of 15,400 acres seasonally irrigated. The remaining 22 percent is supplied by individual farm wells. The irrigated acreage (Fig.9)* represents approximately 57 percent of total crop land and 40 percent of the entire project acreage.

* See appendix

Recent Changes in Land-use. The introduction of irrigation to the project area lands provided the necessary impetus for relatively important changes and trends in land utilization.

Walnuts and citrus fruits were returning substantial profits to growers in other irrigated sections with similar environmental conditions, and their adaptability to project area lands had more or less been proven by small ~~family~~ plantings. With irrigation water available, a considerable acreage of bean land was diverted to these crops. Walnut plantings began early in 1923, followed in 1925 by citrus. The demand for suitable land for these crops became so pressing that ^{prices} ~~values~~ soared as high as \$1,500 to \$2,000 an acre for bare bean land.

The acreage developed to walnuts is principally on the irrigated flat land of the Valley ^{Floor} ~~Lowland~~ and Somis Mesa, although a considerable area of dry farmed, fairly level land in canyon locations is also planted.

Citrus plantings were principally Valencia oranges at first. Some lemons and grapefruit were introduced about 1930. These plantings are located on mesa and hillside lands with warm southern exposures where good air drainage provides protection from the winter frosts occasionally experienced on the lower valley lands. The majority of the hillside orchards are contour planted, those on the steeper slopes developing into benches (Fig.10) by constant cultivation on the contour. These practices along with winter cover cropping have admirably controlled rainfall erosion.



CAL-36

Figure 10. Preventing erosion on hillside land by bench terracing. Note the permanent cover maintained on the berms to prevent erosion.

of Australian saltbush (Atriplex semibaccata) and grasses

A summary of the land use on the project is presented in Table 6, (Fig. 11-A)*

Table 6. Acreage and proportionate extent of land use by crops and classes

Land Use	Area	
	Acres	Percent
Beans (1)	18,310.8	47.5
Hay and Grain	1,730.3	4.5
Walnuts	3,851.5	10.0
Citrus (2)	2,343.0	6.1
Other crops (3)	767.5	2.0
All cropland	27,003.1	70.1
Idle land	9,036.1	23.5
Pasture	2,225.0	5.8
Farmsteads	224.2	.6
Total	38,488.4	100.0

(1) Lima and blackeye beans.

(2) Oranges, lemons and grapefruit.

(3) Small acreages of avocados, grapes, apricots and garden crops.

Nearly 50 percent of the area is devoted to bean production. ~~Walnuts,~~ citrus, hay and grain and other crops ranking in the order named, ~~but being of relatively minor importance.~~ Cropland accounts for almost three-quarters of the entire acreage in the area.

Slightly over 23 percent of the area is idle land. This consists of brush land occasionally grazed during the spring in more favorable years, gullies and gullied areas, and other severely eroded land unsuitable for cultivation. Also included in this category are areas with scattered stands of trees not truly classifiable as woodland.

* See appendix

Pastures occupy 5.8 percent of the area. These are unirrigated and of range land character. The 0.6 percent in farmsteads includes farm home sites, barns and corrals.

THE PROBLEM OF SOIL EROSION

Although farmers in most instances had more or less casually recognized the fact that their farm land was undergoing physical changes due to the effects of washing away of the soil, the actual extent, severity and importance of the changes were apparently unrecognized. For example, decreasing yields of lima beans were attributed to other factors, such as low rainfall or insect and plant disease injury. The loss of soil was in some cases so slow that its ~~effect~~ could not be easily detected by the farmer. Thus, the year by year effect of soil loss was apparently of little importance to the operator on the land. Only when the cumulative effect caused drastic reduction in crop yields, formation of gullies, appearance of subsoil and parent material did the farmer realize the importance of the erosional processes. Those farmers who had experienced the effects of erosion resulting in the abandonment of land needed little education on the necessity of practicing soil conservation methods. On the other hand the majority of operators ^{claimed they} still obtained relatively fair ^{returns} ~~yield~~ from lands on which erosion was uncontrolled ^{in spite of}. Thus, a good deal of education was necessary to bring about effective realization of existing and potential conditions.

In order to provide a foundation, not only for the presentation of the problem to the farmer, but also as a basis for development of the project soil conservation working plan and specific erosion control

measures applicable to individual farms, an inventory of the physical features was begun by the Soil Conservation Service following the establishment of the project area. This inventory, or soil conservation survey, incorporated a complete survey of soil types, current land use, slope, and degree of erosion on every acre within the boundaries of the project area.

Through correlation of the various phases of the conservation survey, knowledge of the complexity of the erosional problems, and, by inference, the effect of land utilization on the erosional processes, are ascertainable.

The Conservation Survey

Credit to Kollar?

The conservation survey was originally made on 21,000 acres beginning in May 1934 and completed about the end of that year. Aerial photographs on a scale of 500 feet to the inch were used in preparing the detail base maps upon which was then superimposed the field data. In 1936 the area boundaries were extended to include the present acreage of 38,488 acres. Surveys were completed on the augmented area during the early part of 1937.

In conducting the conservation survey, areas were delineated in the field and mapped according to the following symbol:

SOIL TYPE	-	CURRENT LAND USE OR CROP
SLOPE GROUP	-	CHARACTER AND DEGREE OF EROSION

The soils were mapped in accordance with accepted procedure, that is, as to surface texture and profile development or degree of weathering ~~or disintegration of bedrock~~. Land use, slope groups and erosion were determined by actual observation while in the field.

Soils

NOTE: Soils descriptions beginning with paragraph 2 page 47 and ending paragraph 1 page 52 may be eliminated from the text and placed as a section of the appendix.

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section and in portions of the Camarillo Hills, Las Posas Hills and Foot-hill Region; (3) the residued^{a/} soils of the Altamont series found mainly in the South Mountain section but also interspersed with the old valley filling soils of the other upland sections.

of Mochó, Sorrento and Yolo found

specifically?

The established series on the broad, level coalescing fans of the Valley ^{Floor} ~~Lowland~~ are derived from materials outwashed from sedimentary rock. The more recent overwashes are very noticeable by the extreme light grayish, almost white, tint of the surface layer. The youngest profile of this group is seen in the ~~Panoche~~ ^{Mochó} Series. This soil has a very immature, deeply uniform profile which is readily penetrated by root and moisture. The soils are easily handled, breaking down under cultivation to a small cloddy or granular structure. Lime is found throughout the profile. These soils are largely under irrigation, and are used chiefly in the production of beans and walnuts. Where very recent alluvial materials have been deposited as an overwash on a more mature profile, such as Sorrento or Rincon, the soil is designated as ~~Panoche~~ ^{Mochó} type, Sorrento substratum phase; or ~~Panoche~~ ^{Mochó} type, Rincon substratum phase. Such variations are recognized if the overwash is not deeper than 36 inches. The substratum phases are cropped similarly to typical ~~Panoche~~ ^{Mochó} soils, but have a higher moisture-holding capacity, and are therefore, considered more valuable agriculturally.

The parent material from which the Sorrento Soil Series is derived is identical with that giving rise to the younger more recent Panoche Series. It has, however, been in place long enough to have reached a more mature stage of profile development. The series is distinguished from the related ~~Panoche~~ ^{Mochó} Series in the darker color of the surface soil, and the slight compaction of the subsoil. In the ~~Panoche~~ ^{Mochó}, lime is found throughout the surface layers, while in the older Sorrento soils it has been leached out of the surface soil, but is usually found in the lower part of the subsoil. Soils of this series with a Rincon substratum phase, have a high moisture-holding capacity, and are generally very productive.

Soils of both the Sorrento and ~~Panoche~~ ^{Mochó} series, due to their texture and deep, relatively loose substratum, are particularly susceptible to gully erosion. This activity is accelerated by runoff from clean cultivated areas above. These soils are probably the most valuable agriculturally of any occurring in the area. They have a deep, well-drained profile with sufficient clay accumulation, emphasized in the Sorrento subsoil, to give them good moisture-retaining capacity, yet not enough compaction to retard penetration. Irrigation is generally practiced on these soils.

Yolo Soils are built up from material which has recently been eroded from the hills and deposited on the bottom lands in the form of coalescing alluvial fans. The parent material has apparently been washed from non-calcareous ^{soils and noncalcareous} beds of sandstone. The coarse textured nature of this material has resulted chiefly in the formation of Yolo sands, gravelly sandy loams and sandy loams.

The ~~Panoche~~ ^{Mochó} and Yolo soils are similar, in that they are both recent alluvial soils having no profile development. They differ, in that ~~Panoche~~ ^{Mochó} soils are grayish in color and calcareous throughout their profile, while

The parent material from which the Sorrento Soil Series is derived is identical with that giving rise to the younger more recent Panoche Series. It has, however, been in place long enough to have reached more mature stages of profile development. The series is distinguished from the related Panoche Series in the darker color of the surface and the slight compaction of the subsoil. In the Panoche, lime is throughout the surface layers, while in the older Sorrento soils it has been leached out of the surface soil, but is usually found in the part of the subsoil. Soils of this series with a thin subsoil have a high moisture-holding capacity, and are generally very productive. Soils of both the Sorrento and Panoche series, due to their texture and deep, relatively loose subsoils, are particularly susceptible to erosion. This activity is accelerated by runoff from clean, graded areas above. These soils are probably the most valuable agriculturally of any occurring in the area. They have a deep, well-drained life with sufficient clay accumulation, emphasized in the Sorrento soil, to give them good moisture-retaining capacity, yet not enough to retard penetration. Irrigation is generally practical on these soils.

Yolo Soils are built up from material which has recently been from the hills and deposited on the bottom lands in the form of alluvial fans. The parent material has apparently been washed from the hills and deposited on the bottom lands in the form of calcareous beds of sandstone. The coarse textured nature of this material has resulted chiefly in the formation of Yolo sands, gravels, loams and sandy loams. The Panoche and Yolo soils are similar, in that they are both alluvial soils having no profile development. They differ, in that soils are grayish in color and calcareous throughout their profile.

the Yolo soils are brown in color and non-calcareous. The parent material of these soils has been so recently deposited that weathering processes have not had time to alter the profile to any great extent. Under such conditions, the profile is uniform and it is not possible to differentiate the various soil horizons common to older soils. The profile is commonly stratified with layers of fine sand and coarse material, depending on the velocity of the water which laid it down. The loose structure and coarse texture of these soils when under cultivation, permit rapid moisture penetrations but result in low moisture-holding capacity and poor water storage as a consequence of excessive drainage. Citrus and walnuts under irrigation are the principal crops grown on Yolo soils.

In that Yolo soils are formed from outwash material, they are sometimes underlaid by older soils of different parent material, such as Rincon or Sorrento. These are designated in the Yolo types as Rincon or Sorrento substratum phases. These phases usually have a higher moisture-holding capacity, and are more productive than the typical light-textured soil types.

The hilly to mountainous district occupied by the Altamont Series, immediately separates it from the ~~Panache~~^{Mecho}, Sorrento and Yolo found on the gently rolling to relatively flat bottom lands.

The residual Altamont soils have been developed in place from slightly consolidated sedimentary formations of sandstones to shales which are usually encountered within from three to five feet, while the Rincon^{Ambrose} and ~~Huerhuero~~^{Antioch} soils have been derived from deep un-consolidated material such as old valley-fill or marine terrace deposits. Altamont soils may also be distinguished by a lighter color in the surface soil and less compactness in the subsoil, due perhaps to drainage, than is typical of the Rincon, ^{Ambrose} and Huerhuero soils. Lime is present in the subsoil to varying degrees.

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The hilly to mountainous district occupied by the Altamont Series immediately separates it from the Rincon, Sorrento and Yolo formations. The gently rolling to relatively flat bottom lands.

The residual Altamont soils have been developed in places from highly consolidated sedimentary formations of sandstones to shales which usually encountered within from three to five feet, while the Rincon and Sorrento soils have been derived from deep unconsolidated material as old valley-fill or marine terrace deposits. Altamont soils may be distinguished by a lighter color in the surface soil and less iron in the subsoil, due perhaps to drainage, than is typical of Rincon and Sorrento soils. Lime is present in the subsoil to varying

Generally, the surface soil is loose and friable, contains moderate amounts of organic matter and is easily handled. In localized areas, erosion has been so active that very little, if any, soil profile has had a chance to develop. When such a condition exists, the parent material may be encountered within a few ^{inches} ~~feet~~ of the surface, and will be found covered with light grayish material of light texture, low in organic matter and highly calcareous. The parent ~~material~~ formations vary considerably in their texture, degree of consolidation and lime content. Beds of conglomerate material are found scattered throughout the lower hilly section. In general, the parent material of the hilly region is highly mixed and only very ^{moderately} ~~softly~~ consolidated, while that of the steeper mountain section is fairly uniform and more consolidated.

About one-fourth of the area covered by Altamont soils is used in the production of beans and hay under dry-farming practices. No definite system of rotation has been practiced. The uncultivated hilly and steeply mountainous areas of Altamont soils are vegetated with a native cover of grass and brush. In general, the heavier types support a good grass and weed growth, while sagebrush, yucca and cactus is the typical cover found on the lighter soil types.

and Ambrose

Rincon ^ASoils are formed from material eroded from sedimentary rock and deposited by water as old valley-filling material. This material has been in place for a great many years and is greatly modified by weathering ~~and erosion~~. Its present irregular upland physiographic features are accounted for either by uplift of the material since the time of its deposition, or geologic degradation which has dissected it with valleys and stream channels. These soils usually occupy a position intermediate between the recent alluvial soils on the bottom lands and the residual soil of the steeper hilly to mountainous sections.

Generally, the surface soil is loose and friable, contains moderate amounts of organic matter and is easily handled. In localized areas erosion has been so active that very little, if any, soil profile has had a chance to develop. When such a condition exists, the parent material may be encountered within a few feet of the surface, and will be found covered with light grayish material of light texture, low in iron matter and highly calcareous. The parent material formations vary considerably in their texture, degree of consolidation and time contact. Beds of conglomerate material are found scattered throughout the hilly section. In general, the parent material of the hilly region is highly mixed and only very ^{moderately} consolidated, while that of the or mountain section is fairly uniform and more consolidated. About one-fourth of the area covered by Almont soils is used for production of beans and hay under dry-farming practices. No definite system of rotation has been practiced. The uncultivated hilly and mountainous areas of Almont soils are vegetated with a native of grass and brush. In general, the heavier types support a good and weed growth, while sagebrush, yucca and cactus is the typical found on the lighter soil types. Rincon soils are formed from material eroded from sedimentary ^{and igneous} and deposited by water as old valley-filling material. This material has been in place for a great many years and is greatly modified by weathering. Its present irregular upland physiographic features are accounted for either by uplift of the material since the time of position, or geologic degradation which has dissected it with valleys and stream channels. These soils usually occupy a position intermediate between the recent alluvial soils on the bottom lands and the residual soil of the steeper hilly to mountainous sections.

The dark brownish-gray surface soil of the Rincon series varies in depth with degree of erosion. When cultivated under favorable moisture conditions, it breaks up into a small cloddy to granular structure. The subsoil of yellowish brown color is usually heavier textured and more compacted than the surface layer. The substratum is similar in color to the subsoil, but is more friable, less compact and offers little resistance to the penetration of moisture. Lime has been leached out of the surface and subsoil and is frequently found deposited as soft accumulations in the upper part of the substratum. In general, the Rincon soils are heavy in texture, relatively high in organic matter and have a high moisture-holding capacity.

The Ambrose soils are more strongly weathered than the Rincon soils. The surface is grayish-brown to dull reddish-brown in color, usually small cloddy to finely cubical in structure with a peculiar tendency to slick over rather readily under the impact of rain. The clods melt when wetted, reducing rates of moisture penetration and allowing accumulated rainfall to cause severe sheet erosion. These soils are nearing maturity and approach a clay pan formation which greatly interferes with root and moisture penetration. The substratum is similar to the subsoil in color but is less compact and more friable and so offers less resistance to the penetration of whatever moisture reaches it.

Sheet erosion has done considerable damage, although the Rincon soils are less susceptible to this type of erosion than some of the other soil types occurring in the area. The heavy-textured soil particles, when disturbed, tend to cling together in aggregate formation. Under such conditions, a few gullies are formed, rather than numerous small rills, the former resulting in lesser topsoil loss.

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Sheet erosion has done considerable damage, although the Rincon are less susceptible to this type of erosion than some of the other types occurring in the area. The heavy-textured soil particles, when turned, tend to cling together in aggregate formation. Under such a few gullies are formed, rather than numerous small rills, the result being in lesser topsoil loss.

The parent material from which the Antioch soils have been derived contains an abundant marine fauna, sea shells and other evidences of marine deposition. Apparently after former native material, geologically degraded, was washed down and deposited in the shallow ocean waters, a recession of the ocean or an uplift took place, locating these areas in their present position. Since then the elements have again degraded these newly formed physiographic features, leaving only upland remnants in the form of broken and dissected marine terraces.

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The parent material from which the Antioch soils have been derived contains an abundant marine fauna, see shells and other evidences of marine deposition. Apparently after former native material, geologic degradation, was washed down and deposited in the shallow ocean water, recession of the ocean or an uplift took place, locating these areas at their present position. Since then the elements have again degraded these newly formed physiographic features, leaving only upland remnants in the form of broken and dissected marine terraces.

The surface soil, of grayish-brown color, has a loose single structure, having a low moisture-holding capacity because of the

texture and relatively low organic matter content. The surface soil is underlain by a heavy ~~compact~~, impervious, reddish-colored compacted clay layer, which greatly interferes with root and moisture penetration. After the surface soil or "A" horizon has been lost through erosion these soils are rendered practically valueless agriculturally. The material of the substratum is slightly lighter in color than that of the surface soil, but has a similar loose, friable structure which will readily absorb moisture, but offers little resistance to gullying.

In all, the soils of the area comprise six series containing twenty-seven types and eleven phases. Table 7 gives the acreage and proportionate extent of each type and phase in the order of increasing erodibility.

For purposes of generalization, the soil types and phases listed in table 7 may be broadly classified into six groups (Fig. 11-B)*.

Group 1

Group 1 contains the ^{*Mochó*}~~Panoche~~ and Sorrento series. Soils are of ~~sedimentary~~ ^{*alluvial*} origin recently deposited and slightly to well-flocculated. The Sorrento series contains lime in the subsoil only, while the Panoche is calcareous throughout. Penetration of water is comparatively rapid. These soils are on flat to gentle slopes, generally less than 4 percent. Erosion is inconsequential and gullies occur only as the result of concentrated runoff from adjacent areas with steeper slopes.

Where this type of concentration occurs on longer watersheds, the drainage cuts out rapidly, degrading gullies which entrench themselves and form extremely large vertical-walled barrancas.

With the exception of the lighter textural grades these soils are the most productive on the area. Both irrigated and dry farmed crops of

* See appendix

texture and relatively low organic matter content. The surface is underlain by a heavy compact, impervious, reddish-colored compacted layer, which greatly interferes with root and moisture penetration. The surface soil or "A" horizon has been lost through erosion phases are rendered practically valueless agriculturally. The material has a similar loose, friable structure which will readily absorb but offers little resistance to culturing.

In all, the soils of the area comprise six series containing two seven types and eleven phases. Table 7 gives the acreage and proper extent of each type and phase in the order of increasing erosion. For purposes of generalization, the soil types and phases listed in Table 7 may be broadly classified into six groups (Fig. 11-5):

Group 1

Group 1 contains the Pancho and Sorrento series. Soils are of alluvial origin recently deposited and slightly to well-flocculated. Sorrento series contains lime in the subsoil only, while the Pancho is calcareous throughout. Penetration of water is comparatively rapid. These soils are on flat to gentle slopes, generally less than 4 per cent. Erosion is inconspicuous and gullies occur only as the result of concentrated runoff from adjacent areas with steeper slopes. Where this type of concentration occurs on longer watersheds, drainage cuts out rapidly, forming gullies which entrench themselves into extremely large vertical-walled terraces. With the exception of the lighter textured grades these soils are most productive on the area. Both irrigated and dry farmed crops

Table 7

Area and proportionate extent of soil types listed in order of increasing erosibility

Soil Type	Acres	Percent
Mocho loamy sand	II 246.7	.6
Mocho gravelly sandy loam	II 475.5	1.2
Mocho gravelly sandy loam (shallow phase over Sorrento)	I 13.7	(1)
Mocho loam	I 1604.2	4.2
Mocho loam (shallow phase over Sorrento)	II 50.1	.1
Mocho loam (shallow phase over Rincon)	II 53.2	.1
Mocho clay loam	I 2159.6	5.6
Mocho clay loam (shallow phase over Sorrento)	II 132.3	.3
Mocho clay loam (shallow phase over Rincon)	I 112.2	.3
Mocho silty clay loam	246.4	.8
Sorrento sandy loam	1224.2	3.2
Sorrento loam	1177.4	3.1
Sorrento clay loam	2066.5	5.4
Sorrento silty clay	1397.9	3.7
Yolo gravelly sand	205.1	.5
Yolo fine sand	998.6	2.6
Yolo fine sand (shallow phase over Sorrento)	108.6	.3
Yolo fine sand (shallow phase over Rincon)	109.9	.3
Yolo sandy loam	1049.8	2.7
Yolo sandy loam (shallow phase over Sorrento)	115.2	.3
Yolo sandy loam (shallow phase over Rincon)	153.5	.4
Yolo loam	383.1	1.0
Yolo loam (shallow phase over Rincon)	10.3	(1)
Yolo clay loam	126.8	.3
Rincon loam	713.7	1.9
Rincon clay loam	1048.3	2.7
Rincon clay loam (dark phase)	873.4	2.3
Rincon silty clay loam	2545.8	6.6
Rincon clay	1548.8	4.0
Ambrose clay loam	729.9	1.9
Ambrose clay	184.4	.5
Antioch fine sandy loam	2705.7	7.0
Antioch gravelly sandy loam	782.2	2.0
Antioch loam	3114.8	8.1
Altamont clay	2864.7	7.4
Altamont clay loam	3120.9	8.1
Altamont loam	2466.1	6.4
Altamont sandy loam	562.9	1.5
Altamont gravelly sandy loam	1006.0	2.6
	38488.4	100.0

(1) Less than 0.1 percent.

Table 7

Area and proportionate extent of soil types listed in order of increasing acidity

Soil Type	Acres
Altamont gravelly sandy loam	1006.0
Altamont sandy loam	323.3
Altamont loam	2488.1
Altamont clay loam	3120.3
Altamont clay	2884.7
Altamont loam	3114.8
Antioch gravelly sandy loam	782.2
Antioch fine sandy loam	2708.7
Antioch clay	184.4
Antioch clay loam	729.3
Rincon clay	1348.8
Rincon silty clay loam	2345.8
Rincon clay loam (dark phase)	873.4
Rincon clay loam	1048.2
Rincon loam	713.7
Yolo clay loam	128.8
Yolo loam (shallow phase over Rincon)	10.3
Yolo loam	383.1
Yolo sandy loam (shallow phase over Rincon)	153.3
Yolo sandy loam (shallow phase over Sorrento)	115.2
Yolo sandy loam	1049.8
Yolo fine sand (shallow phase over Rincon)	108.3
Yolo fine sand (shallow phase over Sorrento)	108.3
Yolo fine sand	998.8
Yolo gravelly sand	205.1
Sorrento silty clay	1397.9
Sorrento clay loam	2088.5
Sorrento loam	1177.4
Sorrento sandy loam	1234.2
Macho silty clay loam	246.4
Macho clay loam (shallow phase over Rincon)	112.2
Macho clay loam (shallow phase over Sorrento)	133.2
Macho clay loam	2159.8
Macho loam (shallow phase over Rincon)	52.2
Macho loam (shallow phase over Sorrento)	50.1
Macho loam	1804.2
Macho gravelly sandy loam (shallow phase over Sorrento)	13.7
Macho gravelly sandy loam	478.8
Macho loamy sand	246.7

(1) Less than 0.1 percent.

beans, walnuts and citrus are produced on these soils.

Group 2

Group 2 includes the soil types of the Yolo series and all of the substratum phases. These soils are recent alluvial, similar in surface and subsoil development. While characteristically deep, there are many areas of overwash material which are comparatively shallow as is indicated by the number of substratum phases. The textures range from gravelly sand to loam. As these soils are not strongly aggregated, they tend to deflocculate rather readily under the impact of rainfall, being less readily permeable than are the soils of Group 1. They are slightly susceptible to sheet erosion and to gully erosion where concentrated runoff water flows. Slopes range up to 10 percent.

With the exception of the loam textures, the Yolo soils in this area are generally low in productivity. Walnuts, citrus, avocados and some grain hay are cropped on these soils.

Group 3

and Ambrose

In this group are all of the soils of the Rincon series. Most of the types are heavy-textured with heavy to compact subsoils resting on an unconsolidated substratum. These soils are moderately susceptible to sheet erosion and highly susceptible to gully erosion, the latter being spectacular on the steeper slopes where concentration of water has eroded its way through the surface and subsoils into the unconsolidated sugarlike substratum.

In general these soils occur on slopes ranging from 3 to 60 percent.

pears, walnuts and citrus are produced on these soils.

Group 2

Group 2 includes the soil types of the Yolo series and all of the substratum phases. These soils are recent alluvial, similar in surface development. While characteristically deep, there are many of overwash material which are comparatively shallow as is indicated by the number of substratum phases. The textures range from gravelly to loam. As these soils are not strongly aggregated, they tend to flocculate rather readily under the impact of rainfall, being less permeable than are the soils of Group 1. They are slightly susceptible to sheet erosion and to gullying where concentrated runoff water flows. range up to 10 percent.

With the exception of the loam textures, the Yolo soils in this group are generally low in productivity. Walnuts, citrus, avocados and grain may be cropped on these soils.

Group 3

In this group are all of the soils of the Rincon series. Most of these are heavy-textured with heavy to compact subsoils resting on a consolidated substratum. These soils are moderately susceptible to erosion and highly susceptible to gully erosion, the latter being especially so on the steeper slopes where concentration of water has eroded through the surface and subsoils into the unconsolidated sugarlike material. In general these soils occur on slopes ranging from 2 to 30 percent.

The gentler slopes are cropped to beans, citrus and walnuts; the steeper slopes to beans and cereal hay. There are also areas of pasture and idle land. Productivity of these soils are average to moderately high with the exception of the loam which is moderately low.

Group 4

Group 4 consists of the ^{Antioch}~~Eucler~~ types. The surface soil is light to medium textured, single grained, with low organic matter content and low water holding capacity; the subsoils dense, compact clay and the substratum friable and comparatively loose. These soils are highly susceptible to sheet and severe gully erosion. Areas destroyed for cultivation are not uncommon.

Slopes range from 3 to 35 percent.

These soils are devoted to beans, citrus and cereal grain and hay production. Where the surface soil mantle is deep, erosion not excessive and irrigation water available, production is excellent.

Group 5

Group 5 includes the medium to heavy-textured primary Altamont Soils. The subsoils are slightly heavier intexture than are the surface soils. At depths ranging from 24 to 60 inches, the subsoils are underlain by a softly consolidated calcareous sedimentary bedrock. In spite of slopes which range from 10 to 60 percent these soils are only moderately susceptible to sheet and shallow gully erosion. This is due in part to their high degree of aggregation and stability.

The greater slopes are cropped to beans, citrus and walnuts; the smaller slopes to beans and cereal hay. There are also areas of pasture and land. Productivity of these soils are average to moderately high with exception of the lower which is moderately low.

Group 4

Group 4 consists of the heavy-textured types. The surface soil is 12 to medium textured, single grained, with low organic matter content for water holding capacity; the subsoil is dense, compact clay and the stratum friable and comparatively loose. These soils are highly susceptible to sheet and severe gully erosion. Areas destroyed for cultivation are not uncommon.

Slopes range from 3 to 35 percent.

These soils are devoted to beans, citrus and cereal grain and production. Where the surface soil is deep, erosion not excessive and irrigation water available, production is excellent.

Group 5

Group 5 includes the medium to heavy-textured primary Alfisols. The subsoils are slightly heavier textured than the surface soil. At depths ranging from 24 to 60 inches, the subsoils are underlain by a softy consolidated calcareous sedimentary bedrock. In spite of which range from 15 to 30 percent these soils are only moderately susceptible to sheet and shallow gully erosion. This is due in part to their high degree of aggregation and stability.

Group 6

This group consists of the lighter textured Altamont soils which have a surface soil and subsoil only slightly aggregated. Due to lack of a high degree of aggregation and to slopes of 5 to 80 percent these soils are highly susceptible to sheet and shallow gully erosion. They are less desirable for tilled crops, being utilized for pasture or lying idle.

These soils are low in productivity.

Table 8 gives the area and proportionate extent of the soil groups in order of increasing susceptibility to erosion.

Table 8 . Area and proportionate extent of soil groups listed in order of increasing erosibility

Soil Group	Area	
	Acres	Percent
<i>Mocha</i>		
1. Panocha and Sorrento	10,959.9	28.5
2. Yolo	3,260.9	8.5
3. Rincon <i>and Ambrose</i>	7,644.3	19.9
4. Huerfano <i>Antioch</i>	6,602.7	17.1
5. Altamont (heavy textured)	5,985.6	15.5
6. Altamont (light textured)	4,035.0	10.5
Total	38,488.4	100.0

The distribution of each soil group in the several slope classes is given in table 9. Differentiation of slope classes in this survey were in percentage as follows: A, 0 to 2; B, 2 to 10; C, 10 to 25; and D, 25 and above. From the standpoint of total acres in all soil groups, D slopes predominate. Soil groups 1 and 2 predominate in slope classes A and B; group 3 in all slope classes; group 4 in B, C and D; group 5 in class D; group 6 in class D.

This group consists of the lighter textured Altamont soils which have a surface soil and subsoil only slightly aggregated. Due to its of a high degree of aggregation and to slopes of 5 to 20 percent the soils are highly susceptible to sheet and shallow gully erosion. are less desirable for tillied crops, being utilized for pasture or idle. These soils are low in productivity.

Table 3 gives the area and proportionate extent of the soil group in order of increasing susceptibility to erosion.

Table 3. Area and proportionate extent of soil groups listed in order of increasing erodibility

Soil Group	Area
1. Fawcett and Sorrento	10,933.9
2. Yolo	8,280.9
3. Rincon and Arbutus	7,644.3
4. Humboldt and Rock	6,602.7
5. Altamont (heavy textured)	5,985.5
6. Altamont (light textured)	4,038.0
Total	38,488.4

The distribution of each soil group in the several slope classes given in table 2. Differentiation of slope classes in this survey was in percentage as follows: A, 0 to 2; B, 2 to 10; C, 10 to 25; and D, and above. From the standpoint of total acres in all soil groups, D slopes predominate. Soil groups 1 and 2 predominate in slope class and B; group 3 in all slope classes; group 4 in B, C and D; group 5 class D; group 6 in class D.

Table 9. Distribution of soil groups in each slope class

Soil Groups	A slopes		B slopes		C slopes		D slopes	
	Acres	%	Acres	%	Acres	%	Acres	%
1. Panoche ^{Mocha} and Sorrento	6,492.6	73.2	4,269.0	37.1	141.2	2.8	57.1	.4
2. Yolo	1,039.7	11.7	2,071.6	18.0	124.3	2.4	25.3	.2
3. Rincon ^{and} Ambrose	1,201.9	13.6	2,617.8	22.7	2,066.3	40.7	1,758.3	13.5
4. Huerfano ^{Antioch}	135.0	1.5	2,261.3	19.6	2,010.3	39.6	2,196.1	16.9
5. Altamont (heavy)	-----	---	54.0	.5	458.8	9.0	5,472.8	42.0
6. Altamont (light)	-----	---	237.0	2.1	278.8	5.5	3,519.2	27.0
Total	8,869.2	100.0	11,510.7	100.0	5,079.7	100.0	13,028.8	100.0

The usage of project area land with reference to soil groups is given in table 10. Group 1 soils are the most extensively cultivated followed in order by groups 3,4,2. Groups 5 and 6 are less extensively cultivated because of steep slopes. The greater portion of this land is idle or utilized as pasture. Nearly 50 percent of the acreage devoted to bean culture, under which erosion has been so rapidly accelerated, is located on the soils of groups 3 and 4, two of the more erodible groups of the area. The major portion of the acreage devoted to walnuts is on group 1 soils. Approximately 70 percent of the citrus is located on soils groups 1 and 2. Hay and grain are grown principally on group 4 soils. Although the acreage of cereal crops amounts to only 12 percent of the total area in this group severity of and susceptibility to erosion of ^{Antioch} ~~Huerfano~~ soils points to the need of extensive increases of close growing crops, to ~~replace the 51 percent occupied by beans.~~

Table 2. Distribution of soil groups in each slope class

Soil Group	A slopes		B slopes		C slopes		D slopes	
	Acres	%	Acres	%	Acres	%	Acres	%
1. Limestone- Sandy loam	1,332.6	75.2	4,388.0	27.1	141.2	2.2	37.1	0.7
2. Yolo	1,332.7	75.2	2,071.8	12.9	124.2	2.2	28.2	0.5
3. Rincon and Sandy loam	1,201.9	12.6	2,617.8	22.7	2,086.2	40.7	1,758.2	34.1
4. Heavy Sandy loam	125.0	1.5	2,261.2	19.6	2,010.2	39.6	2,198.1	42.8
5. Alluvial (heavy)	---	---	54.0	.5	438.8	8.0	2,572.8	50.2
6. Alluvial (light)	---	---	237.0	2.1	278.8	5.3	2,518.2	49.2
Total	8,888.2	100.0	11,810.7	100.0	8,097.7	100.0	13,028.2	100.0

The usage of project area land with reference to soil groups is given in table 10. Group 1 soils are the most extensively cultivated followed in order by groups 2, 4, 5. Groups 3 and 6 are less extensively cultivated because of steep slopes. The greater portion of this land is or utilized as pasture. Nearly 50 percent of the acreage devoted to bean culture, under which erosion has been so rapidly accelerated, located on the soils of groups 3 and 4, two of the more erodible groups of the area. The major portion of the acreage devoted to wheat is Group 1 soils. Approximately 70 percent of the citrus is located on groups 1 and 2. Hay and grain are grown principally on group 4 soils though the acreage of cereal crops amounts to only 12 percent of the area in this group severity of and susceptibility to erosion of these soils points to the need of extensive increases of close growing crops to replace the 41 percent occupied by beans.

Table 10. Acreage and proportionate extent of land use classes in each soil group

Land use	Group 1 <i>Mocha</i> <i>Pancho</i> and <i>Sorrento</i>		Group 2 <i>Yolo</i>		Group 3 <i>Rincon</i> <i>and</i> <i>Ambrose</i>		Group 4 <i>Antioch</i> <i>Huerhuero</i>		Group 5 Altamont (heavy textured)		Group 6 Altamont (light textured)	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Beans	5,960.9	54.4	1,283.6	39.4	5,461.7	71.4	3,380.2	51.2	1,428.5	23.9	795.9	19.7
Hay and grain	97.7	.9	77.7	2.4	442.5	5.8	794.8	12.0	225.2	3.8	92.4	2.3
Walnuts	2,969.0	27.1	422.4	12.9	306.1	4.0	125.4	1.9	6.8	.1	21.8	.5
Citrus	1,022.9	9.3	538.8	16.5	238.8	3.1	534.8	8.1	7.7	.1	----	---
Other crops	<u>227.3</u>	<u>2.1</u>	<u>151.8</u>	<u>4.6</u>	<u>126.7</u>	<u>1.7</u>	<u>216.2</u>	<u>3.3</u>	<u>2.9</u>	<u>.1</u>	<u>42.6</u>	<u>1.1</u>
All crop land	10,277.8	93.8	2,474.3	75.8	6,575.8	86.0	5,051.4	76.5	1,671.1	28.0	952.7	23.6
Idle land	502.2	4.6	716.6	22.0	896.8	11.7	1,216.6	18.4	3,174.4	53.0	2,529.5	62.7
Pasture	23.2	.2	41.0	1.3	160.5	2.1	311.4	4.7	1,138.5	19.0	550.4	13.7
Farmsteads	<u>156.7</u>	<u>1.4</u>	<u>29.0</u>	<u>.9</u>	<u>11.2</u>	<u>.2</u>	<u>23.3</u>	<u>.4</u>	<u>1.6</u>	<u>(1)</u>	<u>2.4</u>	<u>(1)</u>
Total	10,959.9	100.0	3,260.9	100.0	7,644.3	100.0	6,602.7	100.0	5,985.6	100.0	4,035.0	100.0

(1) Less than 0.1 percent.

Erosion

Accelerated soil erosion on the Las Posas Area results from uncontrolled rainfall run-off associated with injudicious land use. Although high velocity winds are experienced at times throughout the year, erosion from this agency is relatively unimportant at present.

Irrigation water erosion is sometimes severe. It becomes severe with misuse of surface water and improper irrigation grades. Soil losses through the agency of irrigation water has been of relatively minor consequence in this area when compared with that occurring from rainfall.

Causes of Erosion

The early white settlers of the area shared a legacy in common with ~~all~~ ^{other} early settlers on virgin soils in that the land which they took possession of was exceedingly rich. As a natural sequence of virgin conditions, there existed a balance between removal of surface soils and the weathering of material in the formation of these soils. With the advent of the settler, this equilibrium was destroyed and with it erosional processes were rapidly accelerated.

Although records are unavailable as to the rapidity of development of accelerated soil erosion, information deduced from present conditions is indicative of what has happened in the past. The observations of individuals who were among the early settlers in this section lend additional support to these inferences.

Apparently the beginning of accelerated ~~soil erosion dates back to~~

Soil erosion on the low lands is accelerated soil erosion
 resulting from uncontrolled rainfall runoff associated with intensive
 land use. Although high velocity winds are experienced at times the
 out the year, erosion from this agency is relatively unimportant at
 end.

Irrigation water erosion is sometimes severe. This early has
 importance with careless use of ground water and improper irrigation
 grades. Soil losses through the agency of irrigation water has been
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 individuals who were among the early settlers in this section land and
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Apparently the beginning of accelerated soil erosion dates back

erosion followed the introduction of livestock into this section. Overgrazing, especially by sheep, was extensive and the resultant changes in native vegetation, particularly the replacement of perennial grass by annuals of poorer erosion resisting character, inaugurated conditions which established the first trends in accelerated erosion.

The damages resulting from unregulated grazing were, however, inconsequential when compared with that resulting in the succeeding periods when the land was brought into cultivation. The production of grain marked the first period in the history of rapidly accelerated soil erosion. Much land devoted to production of wheat and barley crops in the years between 1880 and 1890 was sloping land in the mesa and hill sections. Because of the seasonal climatic variations in rainfall, the late fall-planted grain crops in many years had not reached a stage of growth so as to adequately protect erodible soils from the effects of high intensity rains of mid-winter. This same condition is true today and, as a result, grain and hay crops are rated as semi-erosion resisting crops only. Although erosion was at times severe, the cumulative effect during this period had not resulted in exigencies requiring the immediate application of erosion control methods. *probably required, but not known & not applied*

With the initiation of bean culture and its expansion from the arable valley and mesa lands to steep slopes of the hill land and lower mountain section, the erosional processes became accelerated far beyond what had been generally experienced under previous types of land use, ~~giving rise to conditions which have involved the activities of the Soil Conservation Service during the past five years of operation on the project area.~~

Almost from its inception, bean farming established itself as a one-crop system. The environmental conditions were especially advantageous

period following the introduction of sheep in this section. Overgrazing was extensive and, as a result, changes occurred in the native vegetation particularly the replacement of perennial grass by annuals of poorer growth-resistant character, inaugurating conditions which established first brands in accelerated erosion.

The changes resulting from unregulated grazing were, however, sequential when compared with that resulting in the succeeding period when the land was brought into cultivation. The production of grain of the first period in the history of rapidly accelerated soil erosion which land devoted to production of wheat and barley crops in the year between 1880 and 1890 was sloping land in the mesa and hill sections. Cause of the seasonal climatic variations in rainfall, the late fall planted grain crops in many years had not reached a stage of growth to adequately protect erodible soils from the effects of high intensity rains of mid-winter. This same condition is true today and, as a result, grain and hay crops are rated as semi-erosion resisting crops only. Though erosion was at times severe, the cumulative effect during this period had not resulted in exigencies requiring the immediate application of erosion control methods.

With the initiation of bean culture and its expansion from the valley and mesa lands to steep slopes of the hill and lower mountain section, the erosional processes became accelerated far beyond what had been generally experienced under previous types of land use, giving to conditions which have involved the activities of the Soil Conservation Service during the past five years of operation on the subject area. Almost from its inception, bean farming established itself as a crop system. The environmental conditions were especially advantageous

and the yields and returns highly satisfactory. The establishment of this system was predicted on the ~~fact~~ ^{theory} that the hazards of dry-farming made necessary clean winter fallow for conservation of moisture for the summer-grown bean crop.

This clean winter fallow, under conditions of high intensity precipitation, has allowed the forces of running water to cause extremely severe soil erosion. In addition, other cultural practices, associated with the one-crop system, has^{ve} over a period of years profoundly affected the physical conditions of the soil, accentuating the rapidity and quantitative effect of storm water in causing soil erosion. Although flat and relatively gently sloping land has been little affected by erosional processes associated with the direct removal of surface soil, the effect of uncontrolled runoff, originating on the uplands of the watershed has gouged out and enlarged normal drainage-ways involving considerable areas of the flat land in the process. In addition, the erosional debris removed from the uplands has been deposited on ^{portions of} the fertile low lands, reducing their value for agricultural crops.

The effects of erosion on sloping land have been clearly indicated by crop yield studies. In 1936, comparison areas, selected in bean fields on dry-farmed land with all conditions similar for each comparison excepting the degree of erosion, produced striking differences in yields of beans. Lower yields of lima beans are shown to be directly correlated with increasing severity of erosion as indicated by the following comparisons:

Comparison 1		
<u>Moderately severe erosion</u>	(70 percent surface soil lost)	428 pounds
<u>Very severe erosion</u>	(100 percent surface soil lost erosion into lower subsoil, severely gullied)	99 pounds
Comparison 2		
<u>Moderate erosion</u>	(30 percent surface soil lost)	807 pounds
<u>Moderately severe erosion</u>	(80 percent surface soil lost)	518 pounds
Comparison 3		
<u>Moderately severe erosion</u>	(70 percent surface soil lost)	1065 pounds
<u>Very severe erosion</u>	(100 percent surface soil lost, erosion into parent material-C Horizon)	294 pounds

Types of Erosion

Erosion on the Los Posas project (Fig. 11C)*, (Fig. 12) is characterized by sheet erosion and two forms of gully erosions.

One phase of

Sheet erosion is a stripping off of imperceptible amounts of surface

Another phase of sheet erosion is

soil. Rill erosion, which is the removal of soil in small concentrated channels, one or two inches in cross section, ~~is also classified as sheet erosion.~~ Although rill erosion is more noticeable the effect of sheet erosion, because of its insidious character, is the more damaging.

The two forms of gully erosion are (1) field gully erosion, and (2) drainage-way erosion. Field gully erosion involves small localized areas of land on which erosional processes, resulting from unwise land use and cultural practice, have dissected channels of varying depth. The damage caused by such gullies, which follows severe sheet erosion or rilling of soils with highly erodible subsoils or parent material, not only ultimate -

807 gms	80 percent surface soil lost	Comparison 2	80 percent surface soil lost	807 gms
818 gms	80 percent surface soil lost	Comparison 2	80 percent surface soil lost	818 gms
1000 gms	70 percent surface soil lost	Comparison 3	70 percent surface soil lost	1000 gms
884 gms	100 percent surface soil lost	Comparison 3	100 percent surface soil lost	884 gms
	erosion into lower subsoil		erosion into lower subsoil	
	severely eroded		severely eroded	
	(To percent surface soil lost)		(To percent surface soil lost)	
	Comparison 1		Comparison 1	

Types of Erosion

Erosion on the Las Pintas project (Fig. 111), (Fig. 112) is characterized by sheet erosion and two forms of gully erosion. One form of sheet erosion is a stripping off of large-scale amounts of surface soil. This erosion, which is the removal of soil in small channels or channels, one or two inches in cross section, is also characterized by sheet erosion. Although this erosion is not noticeable in the early stages of erosion, because of its insidious character, is the cause of sheet erosion. Another type of erosion is the removal of soil in small channels or channels, one or two inches in cross section, is also characterized by sheet erosion. One form of sheet erosion is a stripping off of large-scale amounts of surface soil. This erosion, which is the removal of soil in small channels or channels, one or two inches in cross section, is also characterized by sheet erosion. Although this erosion is not noticeable in the early stages of erosion, because of its insidious character, is the cause of sheet erosion.

The two forms of gully erosion are (1) this gully erosion and (2) bridge-very erosion. This gully erosion involves the localities areas of land on which erosion processes, resulting in gully erosion and surface erosion, have dissected channels of varying depth. The damage caused by such gullies, which follow various lines of erosion or ridges of soils with highly erodible material or parent material, not only affects



A.



B.



C.

Figure 12. A, severe sheet erosion. B, severe sheet and field gully erosion. Note rills converging into field gullies and depositional damage in the valley. C, drainage way erosion, entrenchment initiated. Compare with figure 4, page 9.



Figure 12. A, rotary check error; B, rotary
check and field error; C, rotary
into field errors and rotary/field errors in the
yellow; D, distance very small; rotary/field
at. Same as with figure 4, page 8.

ly destroys the area on which processes occur but also reduces the value and utilization of fertile lands below, through deposition of infertile subsoil material.

widening?

Drainage-way erosion involves the deepening and entrenchment of normal drainage ways. On the Las Posas project this type of erosion has given rise to tremendous chasm-like gullies or barrancas (page 9) which presented one of the major problems involving the work of the Soil Conservation Service. These barrancas, originating in the South Mountain and Foothill Region, traverse the mesa and lowland sections, outleting into two main channels, the Arroyo Las Posas and the Las Posas Wash, and provide the drainage system for the greater part of the project area. Prior to the culture of lima beans, these barrancas were relatively small gullies which terminated in alluvial fans on the mesa and lowland, spreading water and erosional debris in fanwise fashion. With the introduction of beans small ditches were put in connecting these gullies with the Arroyo Las Posas and the Las Posas Wash. Both of these water ways were well defined, with channels lying from twenty to fifty feet below the lowland and mesa sections respectively. Apparently the early farmers little realized the effect of concentration of water in unstabilized channels. The man-made ditches rapidly cut back from their terminⁱ in the deeper drainage ways, and with continuing headward erosion, greatly accelerated by additional runoff contributed from sloping land brought into bean production from time to time, ~~dissected~~ ^{were dissected} previously stabilized gullied channels to the point of their origination in the foothills, giving rise to the large drainage barrancas present today. It is estimated that as a result of this entrenchment, approximately 450 acres ^{of irrigatable land} ~~on the Valley Lowland~~ ^{Floor} and Somis Mesa alone, valued at about \$400,000.00, have been destroyed for agricultural use; and this ^{ed} occurring in a period of less than half a century. Furthermore, this does

English?

(irrigable)

not take into account the effect of deposition of infertile materials carried beyond the project and deposited on fertile lowlands lying adjacent to the area boundaries.

Erosion Classes Mapped

Erosion was mapped according to the standard legend of Soil Conservation Service ¹⁴(8) utilizing the following symbols:

- 1+ - No apparent erosion; recent alluvial or colluvial deposits.
- 2 - Slight sheet erosion; less than 25 percent of the surface soil removed.
- 3 - Moderate sheet erosion; 25 - 75 percent of the surface soil removed.
- 4 - Severe sheet erosion; over 75 percent of the surface soil removed.
- 5 - Very severe sheet erosion; erosion into the subsoil and parent material.
- 7 - Occasional gullies; an average of 3 gullies or less per acre; or gullies 100 feet apart or more laterally.
- 8 - Frequent gullies; an average of more than 3 gullies per acre, or gullies less than 100 feet apart laterally, but less than 75 percent of the particular area included within the gullies.
- 9 - Very frequent or destructively large gullies; a network of gullies that has so thoroughly dissected an area that 75 percent or more is included within gullies; essentially destroyed for crop production.

Shallow gullies passable by tillage implements, but which were ineffaceable by normal tillage operations were designated by 7 or 8.

The symbols for sheet erosion were used alone or in combination with gully symbols, as required to express the conditions found. When gully symbol 9 was mapped, no sheet erosion symbol was used.

¹⁴(8) U.S. Soil Conservation Service. Procedure for making soil conservation surveys. Outline No. 4, 1936.

Gully symbols 7 and 8 were always used in conjunction with sheet erosion. A total of 15 separate erosion classes were mapped, viz: 1+, 1+ 7, 2, 27, 28, 3, 37, 38, 4, 47, 48, 5, 57, 58, and 9.

Extent and Severity of Erosion

The extent and severity of erosion are summarized in tables 11 and 12. In table 12 for purposes of convenience of discussion, the 15 erosion classes have been combined into seven groups.

An area of 3,103 acres or 8.1 percent of the project has been essentially destroyed for tillage principally by gullying and 7.2 percent or 2,773 acres has suffered very severe erosion. This embraces 15.3 percent of the area and 5,876.7 acres on which erosion has been so severe that the cost of reclamation through soil conservation treatment is beyond economic justification based upon potential value of the land. The land in these two groups is considered of little value for agricultural purposes.

A further 15.2 percent of the project involving 5,832.6 acres has been subject to severe erosion which has seriously impaired its agricultural value. Without complex and intensive applications of soil conservation measures this land, in a few years, will also be added to the nearly worthless land.

An additional 24.2 percent of the area has undergone moderate to moderately severe erosion. Effective and economical erosion control on this land will be seriously jeopardized unless immediate application of soil conservation measures are made.

Although 41 percent of the project area has suffered slight erosion only a minor portion can withstand indefinite agricultural usage without simple soil conserving treatment.

Table 11. Acreage and proportionate extent of erosion classes

Erosion Symbol	Description	Area	
		Acres	Percent
1+ -----	No apparent erosion; recent alluvial or colluvial deposits-----	940.5	2.4
1+7-----	Recent alluvial or colluvial deposits with occasional gullies-----	716.7	1.9
2 -----	Slight sheet erosion; less than 25 percent surface soil removed-----	12,366.5	32.1
27-----	Slight sheet erosion with occasional gullies-----	3,430.4	8.9
28-----	Slight sheet erosion with frequent gullies-----	304.4	.8
3 -----	Moderate sheet erosion; 25-75 percent of surface soil removed-----	3,272.1	8.5
37 -----	Moderate sheet erosion with occasion- al gullies-----	4,624.0	12.0
38 -----	Moderate sheet erosion with frequent gullies-----	1,124.5	2.9
4 -----	Severe sheet erosion; over 75 per- cent of surface soil removed-----	1,759.2	4.6
47 -----	Severe sheet erosion with occasional gullies-----	4,073.4	10.6
48 -----	Severe sheet erosion with frequent gullies-----	2,773.0	7.2
5 -----	Very severe sheet erosion; erosion in- to subsoil and parent material-----	130.4	.3
57 -----	Very severe sheet erosion with occas- ional gullies-----	112.3	.3
58 -----	Very severe sheet erosion with frequ- ent gullies-----	181.5	.5
9 -----	Essentially destroyed by gullies ----	<u>2,679.5</u>	<u>7.0</u>
Total -----	-----	38,488.4	100.0

Table 12. Acreage and proportionate extent of erosion groups

Erosion group	Erosion class	Area	
		Acres	Percent
No apparent erosion; recent alluvial or colluvial deposits-----	1+, 1+7,-----	1,657.2	4.3
Slight erosion-----	2, 27-----	15,796.9	41.0
Moderate erosion-----	28, 3, 37 -----	8,200.5	21.3
Moderately severe erosion-----	38 -----	1,124.5	2.9
Severe erosion-----	4, 47,-----	5,832.6	15.2
Very severe erosion-----	48 -----	2,773.0	7.2
Essentially destroyed for tillage---	5, 57, 58, 9----	<u>3,103.7</u>	<u>8.1</u>
Total-----	-----	38,488.4	100.0

Table 11. Acreage and proportionate extent of erosion classes

Erosion Symbol	Description	Area	Percent
14	No apparent erosion; recent alluvial or colluvial deposits	940.5	2.4
147	Recent alluvial or colluvial deposits with occasional gullies	716.7	1.9
2	Slight sheet erosion; less than 25 percent surface soil removed	12,366.3	32.1
27	Slight sheet erosion with occasional gullies	2,430.4	6.6
28	Slight sheet erosion with frequent gullies	304.4	.8
3	Moderate sheet erosion; 25-75 percent of surface soil removed	2,272.1	6.2
37	Moderate sheet erosion with occasional gullies	4,624.0	12.0
38	Moderate sheet erosion with frequent gullies	1,124.8	2.9
4	Severe sheet erosion; over 75 percent of surface soil removed	1,738.2	4.6
47	Severe sheet erosion with occasional gullies	4,072.4	10.8
48	Severe sheet erosion with frequent gullies	2,773.0	7.3
5	Very severe sheet erosion; erosion in to subsoil and parent material	130.4	.3
57	Very severe sheet erosion with occasional gullies	112.2	.3
58	Very severe sheet erosion with frequent gullies	161.5	.3
9	Essentially destroyed by gullies	2,672.2	7.0
Total		38,482.4	100.0

Table 12. Acreage and proportionate extent of erosion groups

Erosion group	Erosion class	Area	Percent
No apparent erosion; recent alluvial or colluvial deposits	14, 147	1,657.2	4.3
Slight erosion	2, 27, 28	15,736.9	41.0
Moderate erosion	3, 37, 38	6,200.5	16.1
Moderately severe erosion	4, 47, 48	1,124.8	2.9
Severe erosion	5, 57, 58	2,672.2	6.9
Very severe erosion	6, 67, 68	2,773.0	7.2
Essentially destroyed by gullies	9	2,102.7	5.4
Total		38,482.4	100.0

Relation of Erosion to Slope

Degree of slope is one of the major factors affecting water erosion where types of land use accelerate erosional processes.

In the conservation survey, slope classes were established to express permissible land use with respect to erosion control. A slopes are the nearly level areas where there is practically no erosion or only slight erosion under any type of cultivation. B slopes are subject to active erosion when cultivated but effective control measures can be established on them thereby permitting continued cultivation. C slopes are too steep for practical erosion control under clean cultivation during the winter rainy season. They are, however, suitable for summer crops where proper winter protective measures are employed. D slopes are too steep for cultivation and should be maintained in permanent cover such as grass, trees, shrubs or other erosionresisting vegetation. The dominant limits of these slope classes as defined by the soil conservation survey are, in percentage: A, 0 to 2; B, 2 to 10; C, 10 to 25; and D, 25 and over.

The relation of erosion to slope is presented in table 13. On 87.4 percent of the A slopes of the project area erosion is slight. The 0.9 percent essentially destroyed for tillage is the result of entrenchment of drainage way gullies. There is no apparent erosion on the remainder of A slopes but there are areas of recent accumulations arising from deposition of erosional materials discharged from the uplands of the project. On B slopes slight erosion has occurred on 67.2 percent of the land and moderate erosion on 19.7 percent. Erosion greater than moderate has involved 7.4 percent of B slopes with 4.7 percent being essentially destroyed for tillage. On 72.4 percent of the C slopes erosion is moderate to moderately severe and 21.8 percent is severe or greater. On D slopes 16.5 percent of the land has been essentially destroyed for tillage, 59.3 percent subjected to severe to very severe erosion and 21.7 percent to moderate erosion.

Table 13. Distribution of erosion in each slope class

Erosion Group	A slopes		B slopes		C slopes		D slopes	
	Acres	%	Acres	%	Acres	%	Acres	%
No apparent erosion, recent deposition	1,001.0	11.3	656.2	5.7				
Slight erosion	7,752.2	87.4	7,732.7	67.2	296.6	5.3	15.4	.1
Moderate erosion	37.4	.4	2,263.0	19.7	3,070.7	60.5	2,829.4	21.7
Moderately severe erosion			212.6	1.8	602.4	11.9	309.5	2.4
Severe erosion			61.6	.5	478.3	9.4	5,292.7	40.6
Very severe erosion			49.7	.4	284.7	5.6	2,438.6	18.7
Essentially destroyed for tillage	78.6	.9	534.9	4.7	347.0	6.8	2,143.2	16.5
Total	8,869.2	100.0	11,510.7	100.0	5,079.7	100.0	13,028.8	100.0

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regala C	regala D	regala B	regala A	quora notioze
Y	Y	Y	Y	Y
1.	4.31	8.3	8.3	8.11
Y.13	4.383.3	8.06	Y.070.3	Y.91
4.3	8.303	8.11	4.303	8.313
8.02	Y.383.3	4.3	2.873	8.
Y.31	8.324.3	8.3	Y.483	4.
8.31	8.324.3	8.3	0.782	Y.3
0.001	8.830.31	0.001	Y.970.3	0.001

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Only 0.1 percent has suffered slight erosion or less.

The major factor influencing erosion has been the type of land use. Table 14. which gives the relation of land use to slope shows that 63.6 percent of C slopes and 27.6 percent of D slopes are cropped to beans. This alone admits injudicious land use and discloses the cause of severe erosion on these slopes. When it is considered that 70.1 percent of the entire project is cropland, that 69.1 percent of the cropland is on B,C, and D slopes and that nearly 50 percent of the total land in the area is devoted to bean production the scope and source of soil erosion is more easily realized.

Relation of Erosion to Land Use

Under virgin conditions the native vegetation was generally sufficient to prevent significant damage by erosion. Cultivation, overgrazing and occasional fires have been responsible for destruction of the natural cover, exposing the soil surface to the action of water erosion.

From the standpoint of acreages in land use classes the most extensive erosion has occurred on cropland devoted to bean culture, followed in order by idle land, pasture and cropland in hay and grain (Table 15). However, the intensity of erosion or degree of severity of erosion has been the greatest on pasture land with idle land, hay and grain and bean land ranking in the order named. Erosion has been relatively unimportant on walnut, citrus and other cropland. The importance of idle land is a reflection of past misuse. A large portion of the acreage in this class represents land previously cropped or pastured and which because of erosional processes has diverted to idle land.

On cropland devoted to beans 46.7 percent or 8,531.9 acres have been moderately to very severely eroded. On hay and grain land 80.7 percent or 2,082 acres are included in the same erosion groups. The hay and

Table 14. Distribution of land use in each slope class and in the entire project and percentage of total area in each slope class

Land use	A slopes		B slopes		C slopes		D slopes		Entire Project	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Beans	4,781.8	53.9	6,702.2	58.2	3,232.6	63.6	3,594.2	27.6	18,310.8	47.5
Hay and grain	102.0	1.2	436.6	3.8	589.2	11.6	602.5	4.6	1,730.3	4.5
Walnuts	2,655.0	29.9	1,131.2	9.8	49.8	1.0	15.5	.1	3,851.5	10.0
Citrus	730.2	8.2	1,470.2	12.8	93.5	1.8	49.1	.4	2,343.0	6.1
Other crops	<u>78.1</u>	<u>.9</u>	<u>498.2</u>	<u>4.3</u>	<u>63.9</u>	<u>1.3</u>	<u>127.3</u>	<u>1.0</u>	<u>767.5</u>	<u>2.0</u>
All crop land	8,347.1	94.1	10,238.4	88.9	4,029.0	79.3	4,388.6	33.7	27,003.1	70.1
Idle land	391.1	4.4	1,077.1	9.4	793.8	15.6	6,774.1	52.0	9,036.1	23.5
Pasture	4.4	.1	104.0	.9	252.5	5.0	1,864.1	14.3	2,225.0	5.8
Farmsteads	<u>126.6</u>	<u>1.4</u>	<u>91.2</u>	<u>.8</u>	<u>4.4</u>	<u>.1</u>	<u>2.0</u>	<u>(1)</u>	<u>224.2</u>	<u>.6</u>
Total	8,869.2	100.0	11,510.7	100.0	5,079.7	100.0	13,028.8	100.0	38,488.4	100.0
Area in each slope class		23.0		29.9		13.2		33.9		100.0
Area of crop land in each slope class		30.9		37.9		14.9		16.3		100.0

(1) Less than 0.1 percent.

Table 15. Distribution of erosion in each land use class

Erosion Group	Cropland												Idle Land	Pasture	Farmstead			
	Bean	Hay and Grain	Walnut	Citrus	Other	Total all												
						Cropland												
Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	
No apparent erosion, recent deposition	619.5	3.4	66.9	3.9	251.9	6.6	153.7	6.6	81.7	10.6	1,173.7	4.3	446.9	4.9	16.0	.7	20.6	9.2
Slight erosion	9,105.1	49.7	315.9	18.2	3,346.4	86.9	1,902.8	81.2	522.2	68.0	15,192.4	56.3	315.0	3.5	97.6	4.4	191.9	85.6
Moderate erosion	4,947.6	27.0	693.4	40.1	226.5	5.9	261.2	11.1	137.9	18.0	6,266.6	23.2	1,222.3	13.5	703.1	31.6	8.4	3.7
Moderately severe erosion	674.1	3.7	131.8	7.6	5.5	.1	15.5	.7	5.0	.7	831.9	3.1	162.4	1.8	130.3	5.9	----	----
Severe erosion	2,414.0	13.2	282.6	16.3	15.6	.4	7.5	.3	20.7	2.7	2,740.4	10.1	2,156.4	23.9	932.5	41.9	3.3	1.5
Very severe erosion	523.4	2.9	239.7	13.9	5.6	.1	2.3	.1	----	----	771.0	2.9	1,699.8	18.8	304.6	13.7	----	----
Essentially destroyed for tillage	27.1	.1	----	----	----	----	----	----	----	----	27.1	.1	3,033.3	33.6	40.9	1.8	----	----
Total	18,310.8	100.0	1,730.3	100.0	3,851.5	100.0	2,343.0	100.0	767.5	100.0	27,003.1	100.0	9,036.1	100.0	2,225.0	100.0	224.2	100.0

grain land was also at one time devoted to continuous bean culture but decreased yields due to the severity of erosional processes caused its diversion. Occasionally the less severely eroded portions are farmed to beans in an irregular rotation.

Moderate to very severe erosion has occurred on 91.7 percent or 8,372 acres of idle land while on pasture land 94.9 percent or 2,082 acres have been involved. The greater portion of this land lies on steep slopes and includes considerable areas once cultivated to hay and grain and beans. In addition portions of the idle land were formerly pastured. It can be inferred that much of the severity of erosion on pasture and idle land has been the result of injudicious practices associated with previous land use. Historically the cycle of land use appears to have been- idle land, hay or grain, beans, ^{back again to} hay or grain, pasture and finally (back again to) idle land. From this it is apparent that bean culture under the system practiced on the project area determines the ultimate utilization of much of the sloping land.

The close relationship of erosion to land use has been disclosed as the result of an erosion survey ⁽¹⁵⁾ of the project area made following the severe storms and floods in the late winter of 1938. The estimated average loss of soil under the different types of land use are shown in table 16. Erosion on idle land was greatest amounting to 175 tons of soil per acre or equivalent to removing a sheet of soil 1.40 inches deep over an entire acre. This was due to the fact that the cover on most of the idle land had been destroyed by fire the previous fall, and had not become re-established in time to protect the soil. Bare winter fallow bean land lost 172 tons per acre or a removal of soil to a depth of 1.37 inches per acre which was nearly as much as that stripped from the steeper idle burned-over brush land. Pasture land and cropland devoted to hay and grain, walnuts

Table 16. Estimated average soil losses, season 1937-38.

Land use	Soil loss per acre	
	Weight Tons	Depth Inches
Idle	175	1.40
Cropland (Winter fallow bean land)	172	1.37
Pasture	89	.71
Cropland (Hay and grain)	80	.64
Orchard (Walnuts)	41	.34
Orchard (Citrus)	26	.21

and citrus lost increasingly smaller amounts. The walnut and citrus land was cover cropped which provided partially effective erosion control.

The Relation of Erosion to Cropping Practices

In general, accelerated erosional processes have been intensified by cropping practices which, although successful from a short-time standpoint, have as the result of continued soil losses proved improvident.

Almost without exception, cropping practices have pursued a course allowing the least protection to the land during critical periods of high rainfall. The pressure of cash returns correlated with the fact that the incorporation of green manures, cover crops and crop residues might interfere with or depress the production of the subsequent cash crop, under climatic conditions existing in this section, has been the major factor discouraging utilization of crop rotations and cropping practices designed to protect the soil and maintain rates of moisture penetration at their maximum.

On the majority of acreage devoted to the production of lima beans, practically no organic matter has been added to the soil since this crop was first produced. The small amounts of volunteer vegetation incorpor-

ated during winter tillage and the root systems of the bean plants left in the soil at harvest time comprise the usual total amount of organic matter added in any one season. As a result of this practice, extending over a period of from 20 to 40 years during which beans have been grown, the reduction in organic matter has been considerable. This decrease is, however, not alone associated with bean production but dates back to early periods of land utilization. Overgrazing by sheep and burning of grain stubble were detrimental practices influencing present conditions.

The diminution in organic matter causing changes in the physical condition of the soil would seem to account for much of the rather intense susceptibility of the sloping cultivated land of this section to the forces of water erosion. The reduction ⁱⁿ ~~of~~ the organic ^{matter} ~~phase~~ definitely tends to change the structure of the soil from a condition characterized by a flocculated crumb structure, that is with soil particles in aggregates, to a deflocculated or dispersed state of single soil particles. Soils low in organic matter tend to "run together" when wetted, the finer soil particles clogging the spaces between larger particles and remaining aggregates, which results in a more or less sealing effect on the surface of the soil, reducing water penetration (¹⁶/₇). Except during very gentle rainstorms the rate of precipitation exceeds the rate of infiltration of moisture into the soil. In cases of higher rates of precipitation any reduction in the rate at which rainwater enters the soil normally, results in

¹⁶
(¹⁶/₇) Recent experimental information indicates that runoff and accompanying soil loss on cultivated land is due almost entirely to the compacting effect of rainfall and the assorting and rearranging of soil particles by running water forming a compacted layer at the immediate soil surface which reduces infiltration and allows accumulated water in running off to cause erosion damage.

Says who? { Duley by Kelly?
The Irish Teacher }

an approximately equal increase in the rate of water accumulation on the surface. Under high intensity storms, as experienced during the winter rainy season, water quickly accumulates on the bare soil surface and under the action of gravity on sloping land runs off, creating serious soil losses through sheet and gully erosion as well as depositional damage to lower lands. The loss of water is important in itself since sustained agriculture both on dry and irrigated land is dependent on water conservation.

Although deep tillage operations for soil preparation such as subsoiling, chiseling or plowing are quite effective in reducing soil and water losses on fallowed bean land during the early part of the winter rainy season, the cloddy open soil surface provided by these operations soon becomes reduced to a relatively impervious condition by the beating action of the rainfall, allowing later rains falling on unreceptive and unprotected soils to cause severe damage (Fig.13).



Fig. 13. Soil surface reduced to a relatively impervious condition by rainfall compaction. Note large clods thrown-up in subsoiling.

an approximately equal increase in the rate of water accumulation on the surface. Under high intensity storms, as experienced during the winter rainy season, water rapidly accumulates on the bare soil surface and under the action of gravity on sloping land runs off, creating serious soil losses through sheet and rill erosion as well as depositional damage to lower lands. The loss of water is important in itself since sustained agriculture both on dry and irrigated land is dependent on water conservation.

Although deep tillage operations for soil preparation such as subsoiling, chiseling or plowing are quite effective in reducing soil and water losses as followed here last during the early part of the winter rainy season, the cloudy open soil surface provided by these operations soon becomes reduced to a relatively impervious condition by the beating action of the rainfall, allowing later rains falling on unresponsive and unprotected soils to cause severe damage (Fig. 13).



Fig. 13. Soil surface reduced to a relatively impervious condition by rainfall action. Note large clods thrown up in subsoiling.

Furthermore, subsequent mid-winter tillage operations such as cycloning, harrowing and discing conducted for the dual purpose of removal of volunteer weed growth for moisture conservation and for seed bed preparation provides from 3 to 6 inches of surface soil in a finely pulverized condition which under high intensity rains of later winter and early spring result in tremendous losses of soil. Of importance in speeding the erosional processes has been the manner in which tillage and cultural practices have been conducted. Much of the land has been cultivated up and down the slope, thus allowing water unimpeded progress in following channels made by the implements, thereby greatly increasing rapidity of runoff and soil losses (Fig. 14). On slopes where the configuration of the land allows concentration of runoff, dissection of the land is rapid and field gully formation a serious problem. Small rills, converging, increase the power of erosivity of runoff with resultant gullying. It is not an uncommon practice to plow-in smaller gullies several times during the winter-fallow season following wash-outs by storms. Usually one or two seasons treatment of this character gives rise to an area abandoned for further cultivation.

The relation of erosion to cropping practices is indicated from historical records of bean yields. Hill land that up to less than a decade ago produced as much as 1500 pounds of beans per acre has, in many instances, dropped to less than 500 pounds of beans per acre. In one case history, representative of many, a field ^{of Altamont clay loam} broken out of virgin cover in 1915 produced an average of 1430 pounds of lima beans per acre per year during twenty consecutive years of cropping. Beginning in 1936, the cumulative effects of soil erosion, continuous cropping and injudicious soil-management practices, resulted in such rapid soil losses during heavy rains in the winter seasons of 1936, 1937 and 1938 that the crop harvested in the

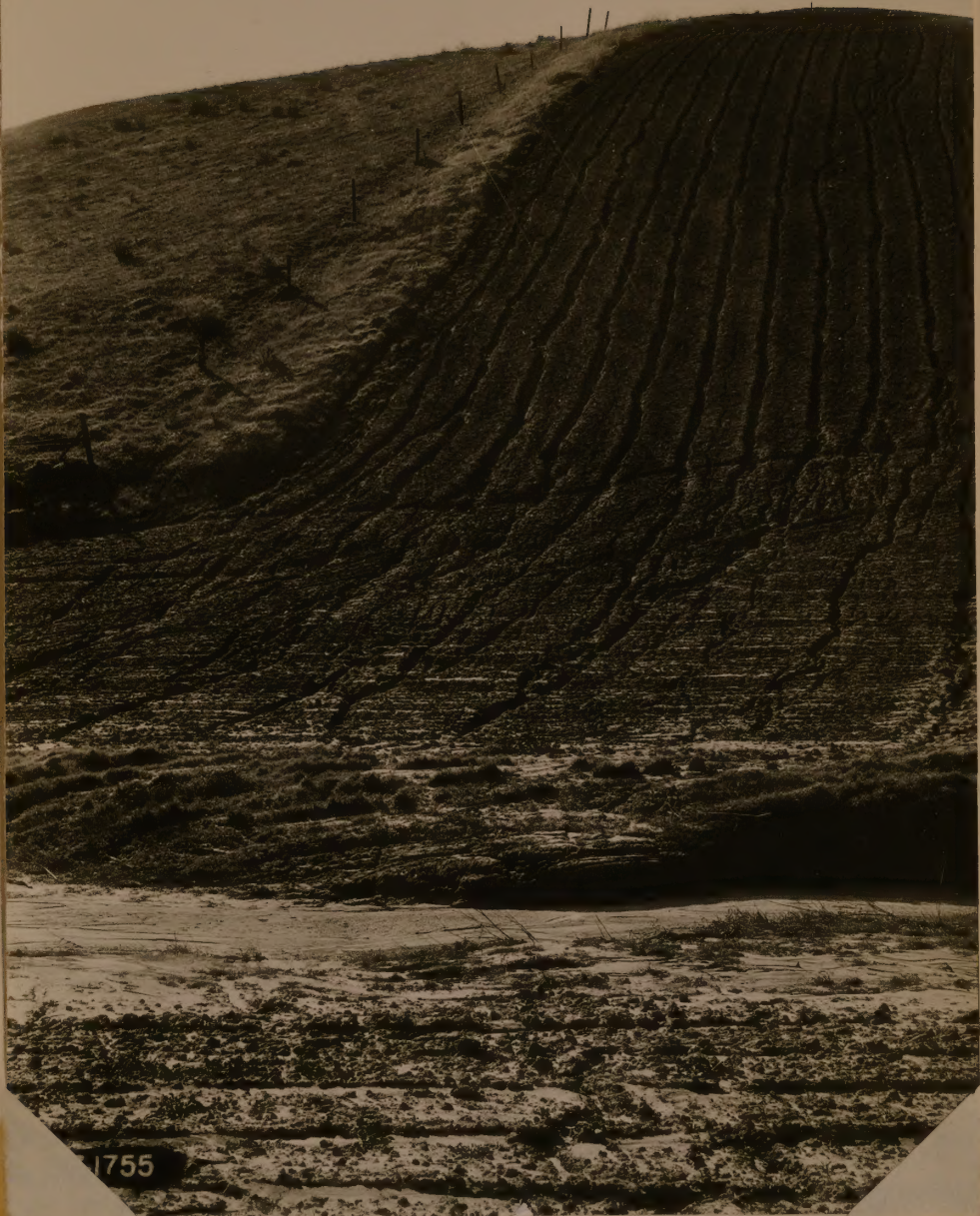


Figure 14. Erosion consequent to subsoiling up and down the slope. No erosion on the pasture on the left.

last year yielded only 375 pounds of beans per acre. Following the harvest of 1938, less than 25 years after the first crop of beans, the farm operator requested advice from the Soil Conservation Service as to the future utilization of the land, since he then felt that lima beans were an uneconomical and injurious crop.

occasional and injurious crop.
utilization of the land, since he then felt that lima beans were an in-
adequate response to the advice from the Soil Conservation Service as to the future
of 1935. Less than 25 years after the first crop of beans, the farm oper-
ated year yielded only 375 pounds of beans per acre. Following the harvest
Figure 12. Erosion consequent to subsiding upland down the slope. No
erosion on the pasture on the left.

Although separate emphasis has been given to the more important factors contributing to accelerated erosion, in the final analysis each factor is interdependent on the other. Thus, the crop system has tended to reduce the organic phase, causing the soil to be more susceptible to erosion. At the same time, various practices involved in the system have multiplied the quantitative effect of this condition. In addition, the degree of erosion itself has had an important influence on the subsequent progress of the erosional processes.

Relation of Erosion to Soils

Soils are variable in their susceptibility to erosion. On a given slope the rate of water penetration ^{is the most important factor} determines the susceptibility of the soil to erosion. Under virgin cover, conditions were not conducive to serious erosion. Soils remained open and permeable. With exposure of the soil surface accompanying overgrazing, removal of vegetation and intense cultivation the desirable structure was destroyed, rates of moisture infiltration reduced and soil losses rapidly accelerated by runoff of accumulated water.

On the basis of erodibility, adduced from the severity of erosion which has occurred in the past, the soils of the project area have been classified into six groups (page 52). The erosion conditions in each soil group are summarized in table 17.

The most serious erosion damage has occurred on soils of groups 5 and 6 which are located on the steeper slopes of the project. On the Altamont heavy textured soils of group 5, 79.3 percent have been moderately severely to very severely eroded. The corresponding extent of erosion on the light textured soils of group 6 has been 78.8 percent. The difference in

Table 17. Distribution of erosion in each soil group

Erosion Group	Soil Group											
	1. Macho Panoche and Sorrento		2. Yolo		3. Rincon Rand Ambrose		4. Antioch Huerfano		5. Altamont (heavy textured)		6. Altamont (light textured)	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No apparent erosion; recent deposition	685.9	6.2	958.4	29.4	2.5		5.8	.1			4.6	
Slight erosion	9,303.1	84.8	1,929.9	59.3	3,052.9	40.0	1,392.6	21.1	95.2	1.6	23.2	.5
Moderate erosion	508.3	4.7	241.3	7.4	3,076.2	40.2	2,406.9	36.4	1,136.9	19.1	830.9	20.7
Moderately severe erosion	64.2	.6	44.3	1.3	272.6	3.5	587.9	8.9	93.5	1.5	62.0	1.6
Severe erosion	30.0	.3	4.8	.1	630.8	8.3	1,137.6	17.2	2,548.3	42.6	1,481.1	36.9
Very severe erosion	9.8	.1	----	----	163.4	2.2	614.9	9.4	1,068.2	17.8	916.7	22.7
Essentially destroy- ed for tillage	358.6	3.3	82.2	2.5	445.9	5.8	457.0	6.9	1,043.5	17.4	716.5	17.6
Total	10,959.9	100.0	3,260.9	100.0	7,644.3	100.0	6,602.7	100.0	5,985.6	100.0	4,035.0	100.0

placement of these groups with respect to order of erodibility is due to the fact that very severe erosion has occurred on 40.3 percent of group 6 soils while only 35.2 percent of group 5 soils have been similarly affected.

Group 3 and 4 soils lying intermediately between the valley land alluvial soils of groups 1 and 2 and the steep foothill and mountainous soils of groups 5 and 6 are the next most susceptible to erosion. Slight to moderate erosion has occurred on 80.2 percent of group 3, ^{and Ambrose} Rincon₁ soils, and 57.5 percent on group 4, ^{Antioch} ~~Huerfuer~~ soils. In addition 42.4 percent of group 4 soils have been subjected to moderately severe to very severe erosion as compared with 19.8 percent on group 3 soils.

On the alluvial soil of groups 1 and 2 including ^{Macho} ~~Pancho~~, Sorrento and Yolo soils, slight erosion or less has occurred on 91 percent of the land.

Erosion Control by Farmers

As critical situations arose from time to time farmers, both individually and in small groups, found it necessary to undertake the application of measures for the control of erosion. These particularly involved the installation of structures such as head controls, over-pours, and dams to prevent the engulfing of large acreages of valuable lowlands in the barranca drainageways.

Several large soil saving dams were built during the decade beginning in 1920. In the Las Posas Wash, which had begun to seriously cut back from the lower lying Oxnard Plains, at about that time, causing extensive land losses, a structure some 40 feet high costing approximately \$20,000 was built by a group of ranchers. This same structure (Fig. 15) was raised to a height of 52 feet by the Soil Conservation Service in 1936 with contrib-

utions of \$12,000 supplied by the individuals originally interested.



Figure 15. The Las Posas Wash Dam, cooperation in soil conservation. This large soil-saving and gully control structure was built at a cost of \$32,000, contributed by land owners adjacent to the gully.

On cultivated land, in instances where small field gullies had begun to form, bean straw dams were placed at critical points along the gully channel. These were of a temporary nature and in many instances resulted in greater damage, through under-cutting, than if such types of control had not been installed at all (Fig.16).

The control of sheet erosion, which is of fundamental importance to the continued stability of agriculture was generally unrecognized as an important phase of economic crop production on area lands. Some practices conducted in conjunction with the types of agriculture established were, however, in themselves soil conserving measures. Thus, early winter tillage practices on bean land, especially when conducted on the contour, were beneficial. Cover cropping and incorporating of bean straw in orchards, both practices for soil improvement, helped minimize soil losses on much of the land devoted to citrus and walnuts.

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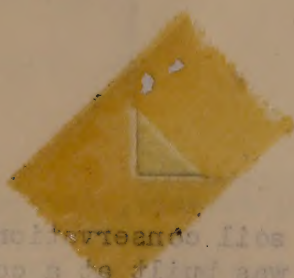
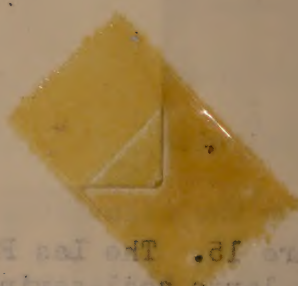
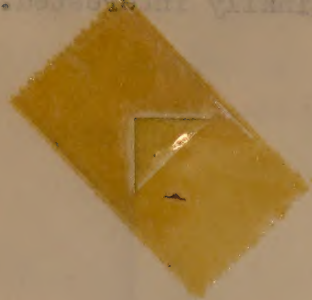
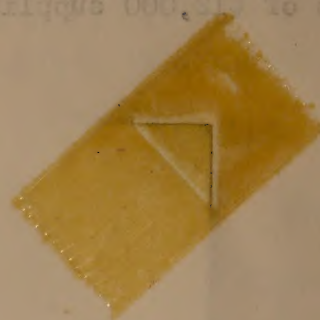


Figure 15. The Las Posas Wash Dam, cooperation in soil conservation. This large soil-saving and gully control structure was built at a cost of \$22,000, contributed by land owners adjacent to the gully.

On cultivated land, in instances where small field gullies had been too far, bean straw dams were placed at critical points along the gully channel. These were of a temporary nature and in many instances resulted in greater damage, through under-cutting, than if such type of control had not been installed at all (Fig. 16).

The control of sheet erosion, which is of fundamental importance to the continued stability of agriculture was generally unrecognized as an important phase of economic crop production on arid lands. Some practices conducted in conjunction with the types of agriculture established were, however, in themselves soil conserving measures. Thus, early winter tillage practices on bean land, especially when combined on the contour were beneficial. Cover cropping and incorporating of bean straw in orchards, both practices for soil improvement, helped minimize soil losses on much of the land devoted to citrus and walnuts.



Figure 16. Bean straw dams for field gully control. Note damage from undercutting in left foreground. This field averaged 99 pounds of lima beans per acre in 1936- less than the amount planted for seed.

Some work by farmers has been specifically directed toward the control of erosion on the land. In one or two instances farmers constructed annual diversion ditches to reduce extensive damages from sheet and gully erosion on steeply sloping winter fallow bean land. The development of bench terraces, sometimes referred to as the Reddick-type terrace, because of H.E.Reddicks effort to adapt them to southern California orchards, was a means of utilizing favorably situated hillside land with slope grades ranging from 15 percent to 25 percent for citrus and other subtropical fruits without erosional losses.

Although the need of control of gullies was generally recognized by the farmers, the lack of coordinated program of soil conservation, both

Figure 16. Bean straw dams for field gulch control. Total damage from
undercutting in left foreground. This field averaged 98 pounds of bean
beans per acre in 1938-1939 less than the amount planted for seed.

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Although the need of control of gullies was generally recognized by
the farmers, the lack of coordinated program of soil conservation, both

in the gullies and on the land, allowed a continuance of erosional processes at ever increasing rates.

THE WORK OF THE SOIL CONSERVATION SERVICE

The project established by the Federal Government on the Las Posas area in 1934 to demonstrate methods and practices for soil conservation was the first of such projects in California and the seventh in the United States.

In review, the major purposes to be served by these demonstrations were as follows:

(1) Education of the public. A well-organized and skillfully applied agricultural plan of considerable size would attract wide attention. This would arouse the interest of the community in examining the work and would lead gradually to an appreciation of an existing erosion problem that perhaps previously had been unrecognized. The understanding of the problem would begin with the participating farmer cooperators and gradually spread outward.

(2) Proving of practices. On a demonstration of this type both old and new measures and practices, either singly or in groups, are applied to the land. It is necessary to give these measures of erosion control a fair trial under the natural conditions and actual farming practice in order to determine their effectiveness and to give an opportunity for further development. The most useful measures are recognized and made available for application by farmers elsewhere.

(3) Training of technicians. It has been found that a man trained primarily in agronomy, engineering, forestry, or any other agricultural specialty is not ~~properly~~ ^{fully} equipped to plan and apply erosion-control

measures without considerable actual experience. The demonstration areas are the training grounds for men in agricultural professions to equip them further in the art of planning and directing the varied activities that are a part of a sound soil and water conservation program.

Project Organization

The project organization consists of a technical section, a field operations section and a clerical section, all under the supervision of the project manager.

The technical section includes a soils expert, an agronomist, an engineer, a forester, a biologist, who is concerned with wildlife conservation, and a farm planner. ^{All} Each of these individuals, as experts in their field, pool their knowledge and, under the direction of the project manager, devise in cooperation with the interested farmers on the project area, plans of conservation operations.

The field operations section consists of a field superintendent, squad foremen and laborers who function under the supervision of the technical section and assist the farmer where necessary in carrying out details of his plan of conservation operations as contracted with the Soil Conservation Service. One of the important phases of the demonstrational area work has been the utilization of large numbers of unemployed. Allotment of funds by the Works Progress Administration and the United States Department of Agriculture has enabled the Soil Conservation Service to employ a considerable number of workers in carrying out constructive activity in the field. The field operations section also includes the complement of labor provided by Civillian Conservation Corps camps, whose work is also under the supervision of the technical section. Two camps

were in operation on the Las Posas project prior to March 1, 1936 and one since that date to the present time.

The clerical section provides the necessary aid in administrative, stenographic and clerical assistance to the technical section, operating directly under a project clerk responsible to the project manager.

From January 12, 1934 to July 1, 1936 the Las Posas project was under the direct jurisdiction of the California-Nevada regional headquarters of the Soil Conservation Service, also located at Santa Paula, California. During this period, the project operations were supervised by the regional office technical sections. Following a reorganization on July 1, ¹⁹³⁶ the present project organization was set up.

Planning Soil Conserving Farm Programs

The basis for attacking the problems of soil erosion and the demonstration of practices designed to control them is provided through the medium of conservation plans incorporated into a cooperative agreement. The cooperative agreement is a contract in which the interested farmer agrees to cooperate with Federal Government in carrying out a plan of conservation operations. This cooperative agreement runs for a period of five years and sets forth in detail what each party agrees to furnish with reference to materials, labor, equipment and technical assistance and indicates which party to the agreement will carry out various provisions.

The method evolved on the Las Posas project for the consumation of the cooperative agreement is as follows: The interested farm owner makes application to the project manager requesting assistance. The project manager after reviewing the problems of the prospective cooperator,

assigns the application for further action to the farm planner or project conservationist. The project conservationist, on receiving the application, makes a preliminary survey of the farm jointly with the farm owner. At this time a land-use ^{map} map, based upon the conservation survey, is prepared showing the various fields, location of gullies, buildings and fences. Field notes and comments of the farmer in regard to cropping practices and conditions on the farm which might influence preparations of the plan of conservation operations are taken. This preliminary survey, indicating problems that exist in each field together with preliminary recommendations which the conservationist and farmer consider feasible, is then submitted to other members of the technical staff for their consideration. These individuals then review the problems and recommendations in the field as a group or singly, with or without the farmer, depending upon the complexity of the problems and the changes in practices or land use which may be necessary to establish a sound coordinated soil conservation program for the farm. The recommendations of the technicians are then incorporated into the plan of conservation operations which are resubmitted to the farm planner who again reviews them jointly with the farmer to arrive at a satisfactory plan. Following this, the cooperative agreement incorporating the plan of conservation operations as finally agreed upon is written and signed by the cooperating farmer and the project manager, the latter representing the Government.

In general, the objective of the plan of conservation operations, as incorporated into the cooperative agreement, has been to establish a coordinated program of erosion control for the entire farm. In a later section such a plan will be illustrated.

Soil Saving Treatment

Erosion control on the Las Posas area falls into two categories:

(1) control of gully erosion, and (2) control of sheet erosion. Although the mechanics of treatment are different their purposes are fundamentally identical in that measures and methods applied accomplish the same purpose, that is, stabilization of the soil by methods which deprive water of its power of erosivity.

The Control of Gully Erosion.

In review, two types of gullies are prevalent on the project area. These are the drainage type and the field type. The former, normal drainage channels which through conditions previously explained degraded into deep gorge-like gullies or barrancas, presented a major control problem. The latter, although of greater importance from the standpoint of extent of damage to agricultural land, are less spectacular and are controlled comparatively simply.

Control of drainage type gullies. The objective in control of the drainage type gully has been the stabilization of the gully channel from its inception in branch gully heads and fingers to its terminus. This involved the installation of measures to prevent further vertical and lateral cutting. Mechanical or structural types of control are used almost exclusively to obtain initial stabilization so that ^{volunteer or planted} ~~the~~ vegetation ~~which gradually comes in~~ can establish itself. The fact that these drainage type gullies had, prior to the beginning of the demonstrational work of the Soil Conservation Service, cut back on grades as steep as ⁴ 15

percent with over-all lengths varying from a quarter of a mile to 5 miles, and with flows during periods of high intensity storms exceeding in some cases, 4,000 cubic feet per second or 1,800,000 gallons of water per minute, made the use of mechanical controls absolutely essential.

In effecting control in channels of this type the first step was to determine the grade of the entire gully system. Sites were then selected and a number of low-drop soil saving structures, varying in height from 10 to 30 feet, were built at intervals such that the flow line was stabilized against the erosive action of flowing water and vertical cutting eliminated. The use of a number of low-lift structures has the advantage of obtaining a shallow stabilized gully bottom, thus preventing the sloughing off of large areas of adjacent banks and in the end providing a relatively ~~narrow~~ ^{shallow} waterway, minimizing the loss of agricultural land, and providing easier crossings for roadways and farm equipment.

Reinforced concrete has been employed for most of the dams constructed in the control of erosion in these channels. The advantages of this type of material include low maintenance cost and extreme durability. These may, however, be offset by the need of experienced construction men and high material cost. For heights up to 10 feet, straight breastwall dams (Fig. 17) are most economical type requiring simpler forming than arch dams. Semi-circular arch dams (Fig. 18) have proved more economical for heights of 10 to 20 feet. This type of dam also provides improved stilling action for a given length of basin. Concrete ~~gravity~~ dams with a gravity breastwall section have proved to be unsatisfactory. ~~economical.~~ Equally good results with less cost have been secured from either reinforced concrete or rock masonry dams.

R Rock masonry dams (Fig. 19) with gravity sections have proved most economical when suitable rock is easily available in the locality.

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either reinforced concrete or rock masonry dams.
Rock masonry dams (fig. 19) with gravity sections have proved
economical when suitable rock is easily available in the locality

Cal 4947

Straight breast wall

Concrete dam

9 x 12 cm.

Figure 17. Straight breast wall reinforced concrete dam.

Although a large amount of labor is required, it need not be experienced, and unskilled labor such as might be available on a farm may satisfactorily be employed in their construction.

Earth fill dams have been found most successful for wide shallow sections in gullies provided that suitable and adequate fill material is available near the site. They possess the advantage of relatively low



Figure 17. Strength of well reinforced concrete dam.

Although a large amount of labor is required, it need not be expensive and unskilled labor such as might be available on a farm may satisfactorily be employed in their construction.

Earth fill dams have been found most successful for this purpose. Section in gullies provided that suitable and suitable fill material available near the site. They possess the advantage of relatively low



Figure 18. Reinforced concrete semi-circular arch dam. Note upstream siltation and vegetative control of backfills and gully banks.



Figure 19. Rock masonry dam with gravity section.

Figure 18. Reinforced concrete arch dam. Note upstream
siltation and negative control of backfills and gully
control.

Figure 19. Rock masonry dam with gravity section.

material and labor cost, but are rather expensive to build due to the equipment necessary for proper construction. With respect to outlets, two types of earth fill dams have been utilized for the stabilization of drainage way gullies. These are the drop inlet-culvert type and the ~~over-~~
~~head~~ *chute* spillway type. The drop inlet-culvert earth dams (Fig.20) have the



Figure 20. Drop inlet-culvert type earth fill dam utilized as a road crossing.

advantage of making it possible to raise the silt level without impounding large quantities of water. This avoids the danger of failure of the dam due to seepage through the base. Disadvantages of this type of construction lie in the danger of the plugging of culverts with debris and the choking of the outlet by silting in the channel below the dam. Several variations in culverts have been used in this type of construction. Concrete pipe has proved more economical for flows up to those which can be carried by a 36 inch pipe. Chief advantages of the concrete pipe are the ease of placing, long life, and comparatively low initial cost. Corrugated metal pipe culverts up to 48 inches in diameter have been used in place of concrete pipe. Advantages of this type of construction include

material and labor cost, but are rather expensive to build due to
equipment necessary for proper construction. With respect to
two types of earth fill dams have been utilized for the stabilization
of drainage way culverts. These are the drop inlet-culvert type and
the drop inlet-culvert type. The drop inlet-culvert type (Fig. 20)

Fig. 20. Drop inlet-culvert type earth fill dam utilized as a
crossing.
Advantage of making it possible to raise the sill level without the
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the blocking of the outlet by silt in the channel below the dam.
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the cost of stone, low life, and comparatively low initial cost.
Concrete pipe culverts up to 36 inches in diameter have been
in the case of concrete pipe. Advantages of this type of construction

the relative ease of placing large sizes, particularly when labor is limited, and their low initial cost. Disadvantages include shorter life, and danger in excess turbulency^e of water flowing through them which may decrease their capacity. Reinforced concrete culverts have also been used and these have proved most economical where the amount of water flowing demands large cross sections in excess of 8 square feet.

Earth fill dams with an ^{chute} ~~overhead~~ spillway type of outlet (Fig. 21)



Figure 21. ^{Chute} ~~Overhead~~ spillway earthfill dam.

are particularly desirable where upstream siltation from structures below may occur, since there is no danger of choking the outlet and endangering the structure. For dam heights not exceeding 10 feet, vertical drop spill-

the relative ease of placing large pipes, particularly when labor is
limited, and their low initial cost. Disadvantages include a water loss
and danger in excess of normalcy of water flowing through them which may
decrease their capacity. Reinforced concrete culverts have also been used
and these have proved most economical where the amount of water flowing
demands large cross sections in excess of 5 square feet.

With all these advantages, culverts of the type of which (see page 32)

are particularly desirable where upstream siltation from erosion may
occur, since there is no danger of choking the outlet and upstream
the structure. For the best results, the outlet should be at least 10 feet
from the structure.

ways have proved satisfactory. Chutes are employed as spillways for heights above 10 feet. In general, the ~~overhead~~ ^{chute} spillway type earth dam eliminates the hazard of failure due to ponding and seepage of water through the structure.

Pipe and wire check dams, originally constructed because of the relatively low cost of materials required, proved unsatisfactory for the control of larger gullies and have all been replaced by permanent structures. In small tributaries of the larger gullies, dams of this sort less than 3 feet in height have proved adaptable. However, constant annual maintenance is an essential to their permanency.

In the completion of installation of gully control structures, vegetation plays an important role. Raw back fills and unprotected slopes of earth dams, which would be subject to severe erosion, are planted to erosion-resisting types of cover. Perennials such as ice plant (*Mesembrythemum* sp), Kikuyu grass (*Pennisetum clandestinum*), and Australian salt bush (*Atriplex semibaccata*) have proved of value for establishment of permanent vegetative cover on such sites. All of these species have considerable resistance to fire, which is an important factor where occasionally uncontrolled fires sweep through the barrancas from the South Mountain section. Mixtures of bur clover and oats, or sweet clover and oats, are seeded with the species previously mentioned to obtain quick cover during the first year. seepage 87

In establishing vegetation on these sites the application of nitrogenous fertilizers has been especially beneficial. Grasses, in particular, respond giving a more rapid, vigorous, and thick-growing protective cover. With ammonium sulfate and comparable nitrogenous fertilizers 200 to 500 pounds per acre are applied, depending on the nature of the exposed

have been proved satisfactory. These are employed as follows
between above 10 feet. In general, the standard railway type
has eliminated the heavy at intervals the 10 foot and 20 foot
through the structure.

These and other cases, originally constructed because
relatively low cost of materials required, proved unsatisfactory
control of larger gullies and have all been replaced by permanent
structures. In small tributaries of the larger gullies, dams of 10
feet and 5 feet in height have proved adaptable. However, such
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In the completion of installation of fully covered structures
station plays an important role. For back fills and unprotected
of earth bank, which would be subject to severe erosion, are of
erosion-resisting types of cover. Permeable such as the plant
bryophytes and, though grass (Panicum clandestinum), and other
salt grass (Atriplex canescens) have proved of value for establishment
of permanent vegetative cover on such sites. All of these species
considerable resistance to fire, which is an important factor in
definitely unsatisfactory fire cover through the passages from the
mountain section. Mixture of bar clover and alfalfa, or sweet clover
only, are needed with the species previously mentioned to obtain
cover during the first year.

In establishing vegetation on these sites the application of
fertilizers has been especially beneficial. However, in
general, we have given a more rapid response and better growing
cover. With accurate culture and comparable nitrogenous fertilizers
to the same extent as are now applied, depending on the nature of the

surface area being planted. For example, on earth fill dams composed principally of infertile subsoil or substratum material, 500 pounds per acre of ammonium sulfate applied just prior to seeding has given the best results. A light application of mulch material, such as bean or grain straw or brush, has been effective in protecting these areas during the interim of establishment of living vegetation.

In many channels, where the banks are at normal angles of repose and well vegetated, elimination of vertical cutting completes the program of stabilization of the channel. However, where the banks are precipitous and the alignment of the channel irregular, complete control has only been obtained by ^{additional} measures preventing lateral cutting. Masonry retaining walls provide complete bank protection. This type of construction is feasible where suitable rock and labor are available. Constructions of this sort possess the advantage of long life and require comparatively little maintenance. However, it is susceptible to undercutting, if vertical cutting occurs in the channel due to improper location of stabilizing gully structures. Little or no material may be salvaged in the event of such a failure.

Pipe and wire revetments have also proved particularly adaptable for this type of control. Construction materials are frequently available on the farm. In case of failure, much of the material may be salvaged and reused. A disadvantage of this type of construction is its relatively short life, which is generally dependent on the type of fencing used. Single wall revetment, with willow brush backfill, is generally most suitable for low flows where the bend in the channel is slight. Double wall revetment, consisting of two rows of pipe and wire with a loose rock core, is more suitable for heavy flows or where the curve of the channel exceeds 45 degrees.

Various trees, shrubs and grasses such as black locust, (Robinia pseudacacia) elm (Ulmus pumila), eucalyptus, laurel-sumac, (Rhus laurina)

① (Lateral) Post-recess

In many channels, where the bank are at natural angles of well vegetated, elimination of vertical cutting completes the stabilization of the channel. However, where the banks are high and the alignment of the channel irregular, complete control is often obtained by means of lateral lateral cutting. This type of construction provides complete bank protection. This type of construction is suitable where the bank and floor are available. Contrary to this point possess the advantage of low cost and require no special little maintenance. However, it is susceptible to minor erosion of the channel bed in the channel bed to improve location of lateral cutting structures. Little or no material may be required in event of such a failure.

The wire rope structure also provides particularly about this type of control. Construction materials are frequently available on the farm. In case of failure, much of the material may be salvaged and reused. A disadvantage of this type of construction is the relatively short life, which is generally dependent on the type of material. Single wall revetment, with willow brush fascines, is generally suitable for low flows where the bank in the channel is slightly eroded wall revetment, consisting of two rows of pipe and wire mesh fence work area, is more suitable for heavy flows or where the bank of the channel is steep.

Various trees, shrubs and grasses such as black locust, (*Rhus glabra*) also (*Alnus incana*), *Amelanchier*, *Juniperus*, (*Thuja occidentalis*)

willow, giant reed grass, (Arundo donax) and elephant grass (Pennisetum purpureum) are some which have been used to supplement revetment construction and to provide protection for backfills. Such vegetation when well established and properly maintained will in the future often eliminate the need for the revetment entirely.

In a few instances farmers have constructed plank bulkheads for lateral control in these gullies. They form complete protection and make use of materials which are often available on the farm. Labor costs for this type of construction are relatively low. These advantages are, however, discounted somewhat due to the shrinkage and decay of the lumber.

- Vegetative bank linings have proved successful when used on gully banks and sides which have been previously graded to a gentle slope. The chief advantages of such controls lie in the relatively low initial expenditures required for labor and materials in establishing this type of protection and in continuing growth of the plants. This may be offset by (1) the large amount of bank sloping required where the channel bottom is a considerable distance below the land surface and (2) the lack of resistance to abrasion and scouring with high velocity channel flow and silt-laden water. Figure 22 shows a channel lining of ice plant.

In the prevention of headward erosion and fingering at various points throughout the extent of the drainage type gully, diversion ditches have been constructed at points to lead the water away from the areas of concentration, taking it into the gully through over-pours or chutes (Fig. 23) in a manner such that further erosional progress is stopped. Part and full circle metal pipe over-pours with concrete or masonry inlets have been successful for this purpose. This type of construction is



Figure 22. Ice plant (*Mesembryanthemum aequilaterale*) planted for gully channel lining and bank stabilization.

particularly adaptable for outletting terraces into deep barrancas. Full circle pipe over-pours have proved most successful and economical except where accumulations of trash or weeds tend to plug the inlet. Such situations have been improved by the use of part circle pipe and inlet opened at the top. Concrete chutes are particularly adaptable for use in small gullies where it is possible to carry the chute to the bottom of the channel. They are less susceptible than pipe over-pours to failures due to lateral cutting in the barranca, and possess the added advantage of long structural life. Wooden chutes installed by individual farmers have been used as head control structures. Their chief advantage is in economy of materials and ease in construction. These,

Figure 22. See plant (Lycopersicon esculentum) planted for
fully channel drain and bank stabilization.

...for stabilization for collecting water into deep basins.
Full circle pipe water-pipe have proved most successful and economical
except where accumulation of trash or weeds tend to plug the pipe.
Such situations have been improved by the use of half circle pipe and
later opened at the top. Concrete drains are particularly adaptable
use in small ditches where it is possible to carry the water to the
top of the channel. They are less susceptible than pipe over-power to
falling in to prevent outflow in the drainage, and possess the added
advantage of long structural life. Wooden water installed by individual
and farmers have been used as head control structures. Their chief ad-
vantage is economy of materials and ease in construction. These



Figure 23. Gully head control diversion chutes installed and gully banks being prepared for planting.

however, are offset by the comparatively short life of timber.

Areas in which further headward erosion and fingering have been prevented by use of measures described, are further stabilized by planting of trees, shrubs, and grasses. Such areas are particularly desirable for wildlife habitat, and the trees and shrubs planted increase in value for this purpose as they grow larger.

Control of field type gullies. Most of these have been controlled vegetatively through planting to various types of woody plants and grasses. Kikuyu grass, a sod-forming grass, although restricted in usage by the county agricultural commissioner on account of its obnoxious character in becoming a weed pest, has affected complete control (Fig.24) on all sites on

Figure 22. Selfish seed control device in a grass seedling and early
growth being prepared for planting.

However, the effect of the comparatively short life of the

grass in which further downward growth and lignification have been pro-

vented by use of chemical treatment, are further stabilized by planting

of trees, shrubs, and grasses. Such areas are particularly desirable for

stable habitat and the trees and shrubs planted in areas in value for

the purpose as they are larger.

Control of Selfish Seed Control. Most of these have been controlled

vegetatively through planting in various types of woody plants and grasses.

These grasses, a red-topped grass, although restricted in range by the

very artificial conditions on account of its unusual character in

habitat a seed bank, but selected and the control (Fig. 22) on all other



Figure 24. Field gully control with kikuyu grass (Pennisetum clandestinum). Undercutting progressed up this gully to the lower edge of the grass.

which it has been planted. Ice plant, salt bush, and various grasses and legumes, including perennial rye grass, wild oats, bur clover, sweet clover, giant reed grass, giant rye grass, and elephant grass have been used for control of these sites. Of the woody plants, both trees and shrubs have been used. Shrubs include Baccharis species, lemonade berry (Rhus integrifolia), laurel-sumac (Rhus laurina), buck brush (Ceanothus cuneatus), red heart (Ceanothus spinosus), and sugar bush (Rhus ovata). Black locust, pepper tree, siberian elm, arizona ash, and various eucalyptus species and willow trees are utilized for the purpose of control of field gullies.

Kudzu vine, so successful for control of these types of gullies in southwestern United States, was tried without success on this project area.

Most of the species enumerated have been used in mixed plantings, the grasses and legumes being seeded among the trees and shrubs for the purpose of obtaining a quick growth and cover until such a time as the trees and shrubs reach a stage where they can properly protect the area. In

cases where the gullies have been planted to grasses and legumes the banks have been sloped or benched to prepare a suitable site for planting. Where woody plants are used spot planting is made ~~on unprepared sites~~. *without further site preparation.*

General observations indicate that annual grasses are not as desirable as sod forming grasses in the control of field gullies.

In instances where such gullies are rapidly degrading, due to continued runoff from sloping land above, willow pole brush dams, pipe and wire check dams and small concrete check dams have been constructed for stabilization of the flow line and building up of these gullied areas.

Terraces and grade

~~Diversion~~ *divert* ditches have also been put in to ~~shunt~~ the water away from ~~the~~ *gullies* ~~and gully~~ *and gully* heads. Following stabilization of these channels ~~cover~~ *vegetative* is established.

Control of Sheet Erosion.

From a practical standpoint the complete check of surface runoff and soil erosion cannot *always* be expected on agricultural land. The objective in soil conservation is to reduce the effective power of surface runoff such that the removal of soil is minimized to a point where the soil losses are balanced by the amount of soil formed in place. This leads to the need of proper land use and practices which not only improve the soil, maintaining and increasing its level of fertility but ~~also, and~~ at the same time, conserve it by providing for conditions on the soil surface which sustain rates of moisture penetration at their maximum, reducing surface runoff and soil erosion. Other benefits also follow from such practices.

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General observations indicate that annual grasses are not as
able as sod forming grasses in the control of field gullies.
In instances where such gullies are rapidly deepening, due to
timed runoff from sloping land above, willow pole brush dams, or
wire check dams and small concrete check dams have been constructed
stabilization of the flow line and building up of these gullies at
intervals of 100 to 200 feet. These check dams have also been put in to direct the water away from
the gully head. Following stabilization of these channels cover is
at.

Control of Road Erosion.

From a practical standpoint the complete check of surface runoff
soil erosion cannot be expected on agricultural land. The objective
soil conservation is to reduce the effective power of surface runoff
that the removal of soil is minimized to a point where the soil loss
balanced by the amount of soil formed in place. This leads to the
proper food use and practices which not only improve the soil, main-
tain and increasing the level of fertility but also tend at the same time
to provide for conditions on the soil surface which arrest
water of moisture penetration at their maximum, reducing surface run-
and soil erosion. Other benefits also follow from such practices.

Greater amounts of water are conserved and find their way into underground reservoirs, which in this section is important to both dry farmed and irrigated agriculture. In addition, the control of surface runoff prevents the formation of field gullies, and subsequent deposition of erosional debris on fertile lowlands. Total seasonal discharge and peak run-off into drainage type channels during periods of high intensity rainfall are lowered and hence the cost of protecting these channels is reduced.

The following discussion of treatments applied in demonstrating measures for the control of sheet erosion on the project area has been subdivided into sections according to classes of land use. In review these include (1) annually cropped land, (2) orchard land, (3) pasture and range, (4) idle land.

Treatment of Annually Cropped Land

This type of land, devoted mainly to the culture of beans, has presented the major problem in the application of erosion control practices. It is also the ^{principal} ~~major~~ land-use type on the project area, and with it is associated the ^{greater} ~~major~~ soil losses. Approximately 40 percent of the total annually cropped land is under irrigation, the remainder being dry farmed, with production of the crop dependent upon the retention of moisture received during the winter rainy season. The majority of the irrigated land lies on the slopes below 6 percent, while the dry farmed areas begin at 6 percent slope and exceed, in some cases, slopes of 50 percent. The greater portion of the dry farmed land, however, averages approximately 15 percent slope.

In general, rainfall erosion on the irrigated land has been slight and from the standpoint of its control the tillage practices followed have, in most circumstances and on most soils, provided adequate control.

However, continuous cropping to lima beans without the incorporation of organic matter has in many cases lowered the fertility, ^{the} infiltration rate of moisture, and the general physical condition of the soil. The utilization of winter green manure crops of vetch and oats, and the incorporation of crop residues, that is, the bean straw, both introduced in the course of project operations, are remedying this condition. In the long run it is expected that the ^{value} ~~necessity~~ of these practices will become apparent through the increased yields of the bean crop.

For the most part the damage inflicted upon the lower lands arises through deposition and gullying resulting from uncontrolled surface runoff and erosion originating in the uplands. It is to this latter type of land, which is unirrigated, that the erosion control program has been directed. Two types of control measures are involved: (1) Mechanical, and (2) agronomic and vegetative. The mechanical controls involve the construction of grade terraces, including diversion ditches and dikes, and various tillage practices. Agronomic and vegetative controls comprise the application of crop rotations, incorporation of green manure crops and crop residues, and the ^{diversion} ~~retirement~~ of highly erodible or severely eroded areas to erosion-resisting cover, provided by pasture and woodland plantings.

Mechanical Controls

Terracing. Terraces ^{used for erosion control} ~~applied to this phase of control~~ are drainage type terraces and are divided into two general groups: (1) Broad base terraces, and (2) narrow base terraces.

Broad base terraces are those with a base width of 20 to 30 feet

and settled height of 15 to 24 inches. Such terraces have been limited to cross slopes of less than 10 percent for effective results.

Narrow base terraces (Fig. 25) have a base width ranging up to 20 feet,



Figure 25. Narrow base terraces on a cross slope of 16 percent.

with heights when settled of 15 to 24 inches. These terraces are used on cross slopes of 10 to 20 percent. The narrow base type of terrace is actually a diversion ditch inasmuch as such terraces, due to their type of construction, prevent the utilization of the channel and the ridge for production of any crop.

The spacing, length and grade of terraces are determined after consideration of soil, slope, land use, size and shape of field. Under the most favorable conditions lengths should not ordinarily exceed 1500 feet, vertical intervals 10 feet, and grades 0.5 percent. Shorter lengths, closer spacings and steeper grades have been found necessary on areas highly susceptible to erosion.

and settled height of 15 to 24 inches. Such terraces have been limited to cross slopes of less than 10 percent for effective results. Narrow base terraces (Fig. 25) have a base width ranging up to 50 feet



Figure 25. Narrow base terraces on a cross slope of 10 percent.

with heights when settled of 15 to 24 inches. These terraces are used on cross slopes of 10 to 20 percent. The narrow base type of terrace is normally a *fluvial* terrace formed as such terraces, due to their type of construction, prevent the utilization of the channel and the ridge for production of any crop.

The spacing, length and grade of terraces are determined after consideration of soil, slope, land use, size and shape of field. Under the most favorable conditions terraces should not unduly exceed 150 feet vertical distance to foot, and grades 0.5 percent. Steeper terraces, closer spacing and steeper grades have been found necessary on areas highly susceptible to erosion.

Although terracing has been of value in preventing severe rilling and gullying on clean cultivated land by the subdivision of surface runoff into smaller units of flow, it has done little to conserve moisture or check soil losses occurring between terraces. Lack of winter protective cover in the way of vegetation or mulch creates an unfavorable condition for the proper functioning of terraces. Due to this factor and the surface topography, terrace systems designed to control erosion completely would be impractical.

Diversion ditches and dikes are constructed on the same principles as terraces. Generally the diversion ditches have been utilized to intercept runoff from steeply sloping brush land lying above cultivated fields. Dikes are in the nature of large diversion ditches where the runoff to be diverted exceeds the capacity of smaller diversion ditches. Generally these have been constructed in foothill valleys to divert water from the agricultural land into main drainage channels.

In conducting runoff from terrace systems, including diversion ditches and dikes, consideration must be given to the outletting of the water into stabilized channels. Where previously stabilized drainage type gullies lie adjacent to terraced fields, over-pours and chutes are used, such as

those described for protection from fingering and head erosion.

If natural channels are not available or are not suitable, artificial outlet channels are created where they will least interfere with farming operations.

Concrete ditches are frequently used for situations involving large flows or high velocities - specifically, when water is being conveyed at high velocity across agricultural land. They require a minimum amount of maintenance and provide maximum length of life. Concrete channels may be classified into three groups depending upon the shape of their cross section.

1. Part circle ditches. These require the least amount of concrete per foot for a given discharge of water. They are relatively simple to construct and are ideal when inexperienced labor is available. For small discharges this type of construction is the best design.
2. Trapezoidal ditches have proved to be the most practical section for all except low flows. Less hand excavation is required than for part circle ditches, other costs, however, are about the same.
3. Rectangular ditches are useful in special cases where the top width is limited by conditions on the land through which such channels pass. For example, where outlets are carried through citrus orchards,

close planting and available space limiting the size of such ditches, this type design is most satisfactory. Vertical sides also tend to minimize the effects of wave action where changes in alignment occur, and as a result, considerable reduction in the depth of this type ditch is possible

Oil lined channels have not proved entirely satisfactory. Difficulties have been encountered in adequately compacting side slopes. The broad shallow section required, if satisfactory compaction is to be insured, requires the use of more area than for other types of outlets. At best, channels of this character have a high initial cost and a relatively high maintenance charge. Their life is extremely limited. When used as a combination road and ditch where tractors or farm implements cross them, failure frequently occurs due to the penetration of the lining by steel wheeled farm equipment.

For low flows on steep grades pipe lines are the cheapest and simplest outlet construction. This type of conduit has the additional advantage of permitting cultivation across the pipe line, since it is usually placed deep enough in the ground so that heavy equipment may pass over it safely. Both concrete pipe and used steel pipe have been employed for outlets of this type. The former has proved to be the most satisfactory because of its longer life and lower cost of installation. While the latter may prove more economical to purchase, it possesses the disadvantage of a shorter life and the necessity of using expensive welding equipment in joining sections in the field.

Vegetative linings are proving suitable for use in low velocity channels where a wide shallow channel can be constructed and ^{the} run-off conducted is free from silt carried as bed load. Kikuyu grass (*Pennisetum clandestinum*) appears to be most satisfactory for linings in this type of channel.

On some sites unlined channels have proved feasible where the original grades are less than 5 percent. For such circumstances the utilization of concrete checks or drops at intervals to stabilize the channel have proved very satisfactory. Vegetative checks, using elephant grass or willows, where properly maintained, are also satisfactory. In general, unlined channels are limited to non-erosive velocities. There are comparatively

few situations on the project area where the grade is sufficiently low to make this type of outletting ^{entirely} feasible.

Tillage practices. It will be recalled that subsoiling, deep plowing and chiseling practiced by the farmers had for their major purpose interception of winter rainfall ^{so} ~~such~~ ^{an} that adequate supply of soil moisture would be built up for the production of beans during the dry summer period. Prior to the inception of the project program on the Las Posas area little regard was given to ~~the conductance of~~ ^{conducting} these practices strictly on the contour, with the result that only partial benefits both for soil and moisture conservation were obtained. In fact, where these practices were conducted up and down slope the surface runoff caused very severe sheet and gully erosion. Through the establishment of a program ^{of} ~~of~~ tillage strictly on the contour, (Fig. 26) that is across the slope of the land, these



Figure 26. Subsoiling on the contour . Note the large clods broken-out.

practices have been made more beneficial. Under normal conditions of rainfall these operations are ~~completely~~ effective in allowing maximum

low situations on the project area where the grade is sufficiently low to make this type of construction feasible.

Illage practices. It will be recalled that subsiding, deep plowing and chisel plowing practices by the farmers had for their major purpose the retention of water rainfall when the adequate supply of soil moisture would be well up for the production of beans during the dry summer period prior to the inception of the project program on the Las Posas area. Little regard was given to the maintenance of these practices strictly on the contour, with the result that only partial benefits both for soil and moisture conservation were obtained. In fact, where these practices were conducted up and down slope the surface runoff caused very severe sheet and gully erosion. Through the establishment of a project, illage strictly on the contour, (Fig. 26) has been across the slope of the land, these

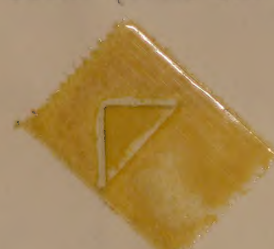


Figure 26. Subsoiling on the contour. Note the large stone pile on the left.

practices have been made very beneficial. Under normal conditions of rainfall these practices are sufficient to maintain a minimum

penetration of water and controlling run-off and soil erosion during the early part of the rainy season. However, the effect of beating rainfall on the surface of the bare soil gradually results in such a reduction of the rate of infiltration that water from later seasonal rains accumulates on the surface of the soil and rapidly runs off causing severe erosion.

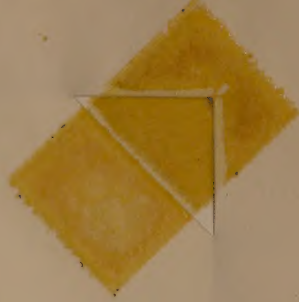
In periods during which benefits of deep tillage practices have been reduced or eliminated, further surface detention of the rainfall has been accomplished by basin listing.

Basin listing (Fig. 27) has been an important contribution to agriculture in this section. The basin lister forms a continuous series of basins which, by variations in the damming attachment and the depth to which the machine is set, forms reservoirs of varying capacity, which impound rainfall and prevent run-off and erosion. The basin lister, or damming lister as it is sometimes called, is a series of listers attached to a rigid steel frame behind which are drawn disc shovels which fit the cross section of the furrows made by the listers. These shovels dragging in the furrows collect the loose dirt in front of them and at intervals,



CAL-42

Figure 27. Basin listing conserves soil and moisture.



either automatically or by power, lift set off by the operator, are raised, leaving small dams which effectively block the furrow. In general, the use of the basin lister has been found applicable only to areas with recent alluvial soils on which slopes do not exceed 10 percent. Deviations from the contour greater than 4 percent have also lessened the effectiveness of the practice. On steeper slopes, especially where the soil is severely eroded, the successive down slope breakage of the basins may cause concentration of runoff with very severe gullying resulting. In some cases this may occur even on gentler slopes where the capacity of the basins ^{is} ~~are~~ exceeded, due to the low permeability of the soil. Where cover crops or green manure crops are seeded in conjunction with basin listing the ^{use} ~~use~~ of this practice has been ^{even} ~~more~~ effective. Erosion damage by overtopping of basins is slight when good cover or green manure crops are growing on them.

Agronomic and Vegetative Controls

Agronomic methods, or in simpler terms scientific crop production methods, utilized in the control of sheet erosion on the annually cropped dry farmed land have been principally concerned with the establishment of crop rotations to replace the condition of continuous bean culture year after year, and its detrimental clean winter fallow under which erosional processes have been so greatly accelerated. Generally, no planned rotations had been initiated by the farmers. Occasionally some of them, when prices were very favorable, replaced beans with hay or grain without, however, any regular scheme or organized program of rotation.

The objective of this phase of the program has been to provide types of rotations in which winter protective cover, either in the form of cash or green manure crops is alternated from year to year with beans. The

winter cover not only affords protection to the soil from the beating action of rainfall, preventing the sealing of the soil surface and maintaining maximum rate of infiltration of water, but also through incorporation of organic matter establishes favorable physical, chemical, and biological conditions for processes of soil formation and enrichment. The improvement of the physical condition alone, is of great importance since this provides a means of continuing maximum rates of water infiltration.

The establishment of crop rotations, involving the use of winter cover crops, has been one of the most difficult problems encountered in the application of the soil conservation program on the project area. The firmly established economic structure and farming practice built up in conjunction with the production of beans over nearly half a century, and the lack of adaptable crops of equivalent cash value which could be incorporated into soil conserving rotations, have hindered the application of the program. Generally the rotation programs which have been introduced to meet conditions existing on annually cropped land have only been partially satisfactory. ~~With the realization of the value of the practices, both from the standpoint of erosion control and cash return, rotations giving more complete protection will be readily adopted by farmers.~~ *None now?*

The rotations at present introduced consist of a semi-erosion-resisting crop of cereal hay or grain alternated with beans (Table 18).

The three year rotation with cereal hay or grain the first year followed by two years of beans provides partial winter protective cover in one year out of three. The stubble, however, which is allowed to remain until late winter of the second year gives considerable resistance to the forces of soil erosion. *particularly if done in a manner which leaves the* The incorporation of the stubble at that time ~~leaves the~~ *trashy and* surface ~~in a roughened condition, which~~ is of benefit in reducing surface runoff and erosion accompanying late winter storms. In addition, a better

Table 18. Soil Conserving Rotations

Rotation No. Type	First Year	Second Year	Third Year	Fourth Year
1. Three year	Hay or grain	Beans	Beans	Hay or grain
2. Two year	Hay or grain	Beans	Hay or grain	Beans
3. Three year	Hay or grain	Volunteer pasture	Beans	Hay or grain

physical condition of the soil, ^{results.} ~~is maintained.~~ Soils under winter fallow in the third year of this rotation have been observed to be less ^{erodible.} ~~subject~~ ~~to erosion.~~

The two year rotation with cereal hay or grain the first year followed by beans the second year is more advantageous than the three year rotation since the soil is subjected to winter fallow only during the latter part of each alternate winter season.

The three year rotation has been found better adapted to areas where lima beans are produced, while the two year rotation works well where black-eye beans are grown. This in itself is important, since the blackeye beans ^{usually} are produced on poor soils of relatively higher erodibility.

Where the diversity of farm enterprises requires considerable pasture the three year rotation with cereal hay or grain the first year followed in the second year by volunteer pasture and the third year by beans has proven the most effective of the rotations introduced. The second year, or volunteer pasture year, gives rise to volunteer cereal grain either of oats or barley, depending upon the cereal used for hay or grain in the first year, bur clover and alfalfa together with other annual grasses. Such a cover is in most years ^{quite} ~~almost completely~~ effective in controlling soil erosion. Furthermore, bur clover, an annual legume, enriches the ?

soil and yields a highly nutritious forage. The volunteer is allowed to remain into mid-winter of the third year, at which time it is incorporated either by plowing or disking. ~~Further erosion following incorporation is negligible, the incorporated organic matter being an important factor in materially improving the physical condition of the soil and its receptivity for rainfall and resistance to erosion.~~ *immediately?*

In attempting to supply ~~the~~ ^{such} needed diversification in cash crops ~~such~~ that rotations would be acceptable, flax seed culture was reintroduced in 1936. It will be recalled that during the decade of 1880 to 1890 flax seed had been grown with considerable success, only to be replaced by beans which were proving to be a relatively higher valued cash crop. Flax as grown in California is a winter crop and fits in well in a rotation with beans. The freedom of the land from weeds and the firm condition of the soil following bean harvest in the fall of the year allows ~~for~~ immediate planting of flax without further preparation of the land, thereby reducing ~~considerably~~ ^{considerably.} its cost of production. ^{relatively} Although flax has been observed to be of ^{low} erosion-resisting character the fact that the practices of clean winter fallow accompanying bean culture are replaced by it results in considerable less soil losses. Notwithstanding that yields of flax were favorable, ~~climatic conditions~~ ^{fogs} occurring at harvest time causing ^e mechanical difficulties in threshing ~~have made~~ ^{and make} extension of flax production rather problematical.

Strip cropping, another means of retarding runoff and soil erosion, by subdividing the slope into contour strips in which alternate close-growing crops cause the water to spread out and drop its load of suspended soil, so successfully practiced in the ^{central and} southern sections of the United States, has not been ^{See Page 112} tried on the project area. ^{Is this correct?} This has been due to the fact that crops of equivalent cash value to beans are not available

for utilization in strip crop type farming.

A form of strip cropping, buffer stripping, introduced as a soil conservation measure has proved ineffective in trials on lands with slopes ranging from 30 to 50 percent. Figure 28 shows contour planted buffer strips



Figure 28. Narrow buffer strips widely spaced are ineffective for control of erosion on 35 percent slopes.

of oats and vetch and bur clover 20 feet wide which due to the steepness of slope and velocity of runoff failed to control surface runoff and soil erosion. It was noted however, that erosion within the strips was considerably less than on the clean cultivated intervals. Comparative soil

for delineation in strip cross section.

A form of strip section, further enlarged, introduced as a well as
surfaces means for cross-sections in which the limits of slopes
range from 10 to 20 percent. Figure 2 shows contour plotted between

Figure 1. Section better shows widely spaced and ineffective for control
of erosion on 25 percent slopes.

of cuts and ditch and bar closer 20 feet wide which due to the steepness
of slope and velocity of runoff failed to control surface runoff and soil
erosion. It was noted however, that erosion within the ditch was con-
siderably less than on the open cultivated intervals. Comparison with

moisture determinations indicated that a greater amount of water was retained in the vegetated buffer strips than on the clean cultivated area. *providing complete winter cover each year*
The use of field rotations, rather than stripping ^{cropping} has been found more effective on steeper slopes of this section.

Successful results have been obtained by a combination of agronomic and mechanical controls through establishment of crop rotations on terraced land. The terraces act to subdivide surface runoff, thus preventing the formation of gullies, while the contour planted semi-erosion resisting winter crops substituted for clean winter fallow decrease runoff and erosion. ~~In this connection, the incorporation of crop residues and green manures enriches the soil and maintains and increases, especially where legumes are used, soil fertility.~~

Retirement Of Annually Cropped Land

Two types of annually cropped dry land have been retired from cultivation: (1) Land with soils of high susceptibility to erosion on which the application of soil conserving practices to allow for continued cropping would be uneconomical; (2) land which through injudicious use has become so severely eroded that profitable annual crop production can no longer be obtained. Groups 4, 5 and 6 soils of the Huerhuero and Altamont series on slopes ranging from 25 percent to 60 percent are particularly involved in retirement treatments.

Two phases of treatment have been accorded areas of the character described: (1) Retirement to pasture and (2) retirement to woodland.

Retirement to pasture. Both permanent and temporary pasture have been established.

Permanent pastures have been established on sites where the severity

of and susceptibility to erosion as the result of continuous bean cropping makes the areas unsuitable for further cultivation.

Areas treated have been retired following a bean harvest. At that time the soil is in a firm condition favorable for direct seeding either by drilling or broadcasting methods. Seeding dry in late fall before the onset of the rainy season has proved to be the most desirable practice for pasture establishment.

A number of different forage plants were tried, both alone and in mixtures, in an effort to provide satisfactory cover and pasturage for these areas. Included were smooth brome grass (Bromus inermis), crested wheat grass (Agropyron cristatum), needle grass (Stipa pulchra), tame oats (Avena sativa), wild oats (Avena fatua), Italian rye grass (Lolium multiflorum), perennial rye grass (Lolium perenne), alfileria (Erodium cicutarium), and the legumes, bur clover (Medicago hispida), sweet clover (Melilotus alba), purple vetch (Vicia atropurpurea) and alfalfa (Medicago sativa). With the exception of perennial rye grass, needle grass, wild oats, alfileria, bur clover, sweet clover and alfalfa the others have proved unadaptable under field treatment. The adaptable species have been seeded in the following types of mixtures: (1) Alfalfa and perennial rye grass; (2) alfalfa, bur clover, perennial rye grass and alfileria; (3) sweet clover, bur clover, wild oats, needle grass, perennial rye grass and alfileria. In order of their listing, these mixtures are applicable to good, fair and poor sites. Under judicious management, pastures produced by these mixtures have proved beneficial in erosion control and provide sustained yields of forage.

Temporary pastures have been established in connection with a long term rotation in which beans replace pasture during two years in a six to eight year rotation period. This type of treatment has been applied

on moderately erodible soils.

~~to areas where erosion has been moderate to moderately severe, and susceptibility of soils to erosion, under clean winter fallow, moderate.~~

Although a complete evaluation of this practice is unavailable at present since the program runs beyond the period reported, it is expected to prove an effective type of treatment. Pastures now established in connection with this rotation have prevented accelerated soil erosion and should continue to provide protection under proper management practices. During the two years of bean production the improved physical condition of the soil gained in the pasture period and the pasture residues incorporated will keep surface runoff and erosion to a minimum. Better crop yields will also be obtained.

Temporary pastures have been established in a similar manner and at the same time of the year as permanent pastures. Alfalfa and perennial rye grass or alfalfa alone have been seeded. ~~When alfalfa is seed alone~~ *A* light seeding of oats or barley is made as a nurse crop *When the rye grass is omitted.*

Proper management has been particularly important ^{to} ~~for~~ establishment and maintenance of these pastures. Considerable harm ^{is} ~~has been~~ done to young plantings by allowing grazing before plants become well established. Overgrazing has also been a factor in reducing forage and increasing hazards of erosion. As alfalfa on dry land tends to thin out rapidly in the course of three to five years even when unpastured, care in management has been necessary to afford maximum ^{use} ~~usage~~ and protection.

Retirement to woodland. Cultivated lands retired to woodland have generally been so severely eroded as to be unsuited for other agricultural ^{use} ~~usage~~. As the result of erosion on these sites, almost all of them are extremely infertile and ^(of low water holding capacity) drouthy. In addition, the aridity of the summer climate and the low humidity accompanying dessicating winds of the

be aware that it is not possible to completely remove and remove
all of the soil in the area of the water table.

Although a complete evaluation of this practice is unavailable at present since the program runs beyond the period reported, it is expected to prove an effective type of treatment. Pastures now established in connection with this rotation have prevented accelerated soil erosion and should continue to provide protection under proper management practices. During the two years of bean production the improved physical condition of the soil gained in the pasture period and the pasture residues incorporated will keep surface runoff and erosion to a minimum. Better crop yields will also be obtained.

Temporary pastures have been established in a similar manner and at the same time of the year as permanent pastures. Alfalfa and perennial ryegrass or alfalfa alone have been seeded. When alfalfa is seeded alone it is not needed of course or barley in such a mixed crop. When the ryegrass proper management has been particularly important for establishment and maintenance of these pastures. Considerable time has been spent in young plantings by allowing grazing before plants become well established. Overgrazing has also been a factor in reducing forage and increasing loss of erosion. As alfalfa on dry land tends to thin out rapidly in the course of three to five years even when irrigated, care in management has been necessary to afford maximum usage and protection.

Retirement to woodland. Cultivated lands retired to woodland have generally been so entirely eroded as to be unsuitable for other agricultural uses. As the result of erosion on these sites, almost all of them are extremely infertile and dry. In addition, the acidity of the summer climate and the low humidity contribute to devastating winds of the

of the fall season contributed to the unfavorableness of such areas for successful woodland use. These conditions coupled with the competition of weeds for whatever moisture and nutrients are available in the soil creates a situation under which satisfactory stands of most woody plants cannot be obtained without application of supplemental maintenance treatment including cultivation and adequate summer and fall irrigation for at least two seasons following the setting out of plantings. *unduly costly?* *see photo p118. These irrigated?*

Stock for both woodland and wildlife plantings were grown in ~~nurseries~~ *Nursery Division.* operated by the Soil Conservation Service. ~~It was especially advantageous to the Las Posas project that the regional headquarters of the Soil Conservation Service Nursery Division as well as the regional nursery unit was located at Santa Paula adjacent to the Project from February 1935 to May 1939. Nursery personnel were thus closely available for consultation on the many difficult plant problems. The very limited rainfall confined to the winter season called for drought resistant plants and also for special conditioning of nursery stock of those plants in order that they would have the best possible chance of becoming established under the long dry season. In this connection the nursery division worked out a simple and inexpensive method of potting plants on a large scale. The special potting method which was devised provided paper containers at one-fifth the cost of the cheapest comparable commercial containers and had other important advantages as applied to large scale production of plants for erosion control planting under conditions existing on the project.~~ *was* *A plug?* *despite* *This*

Some 75 species of trees and shrubs have been planted in the course of treatment of areas ~~retired~~ *devoted* to woodland. Table 19 lists the species and principal use of those which appear to be the most adaptable.

Two types of planting arrangement have been used: (1) Mixtures of trees and shrubs and (2) pure stands of trees, particularly eucalyptus

Table 19. Trees and shrubs which have indicated their adaptability for woodland planting on the Las Posas area.

Name of species	Uses (1)
<u>Trees</u>	
Blue gum (Eucalyptus globulus)	F,W
Red gum (Eucalyptus rostrata)	F,W
Sugar gum (Eucalyptus corymbosa ^{cory})	F,W
Black locust (Robinia pseudacacia)	L,W,F
Arizona ash (Fraxinus velutina)	W,W,F
Siberian elm (Ulmus pumila)	W
Silk oak (Grevillia robusta)	W
Arizona cypress (Cupressus arizonica)	W
Black wood acacia (Acacia melanoxylon)	L,W
White mulberry (Morus alba)	W
Olive (Olea europa)	W
California pepper tree (Schinus molle)	W,F
<u>Shrubs</u>	
Laurel-sumac (Rhus laurina)	W
Lemonade berry (Rhus integrifolia)	W
Sugar bush (Rhus ovata)	W
Buck brush (Ceanothus cuneatus)	W
Red heart (Ceanothus spinosus)	W
Coffee berry (Rhamnus californica)	W
White leaf buckthorn (Rhamnus californica var. toment ^e illa)	W
Australian tea tree (Leptospermum laevigatum)	W

(1) Symbols: F- fuel wood; L- lumber, posts, poles; W- wildlife-food and ~~nesting~~ ^{cover}.

(Fig. 29) and black locust bordered by shrubs and low growing trees. Plant-
ing mixed stands and bordering pure stands ^{with shrubs} are especially favorable for
wildlife.

All plantings of trees and shrubs were made during the winter rainy season. On a number of locations basins varying in size from two to four feet in diameter with wings or small levees on the up-slope side were constructed prior to planting as a means of collecting runoff and inducing



Figure 29. Two year old woodland plantation of Eucalyptus (*Eucalyptus globulus*).

greater penetration of rainfall into the soil. Construction of level terraces, cross checked at intervals of fifteen to twenty feet by low earth banks providing a system of shallow basins was another type of site preparation which allowed both moisture and soil conservation.

The technique of actual planting has been variable. On some sites holes eighteen inches in diameter and as deep or even ^{deeper? greater?} larger were dug and filled with surface soil to provide a better medium of growth for young seedlings planted. The simpler practice of digging holes large enough to accommodate the root system of the type of stock planted has superseded the other method.

Regardless, however, of type of stock used, site preparation and method of planting beyond ordinary care, survival has been ^{almost} uniformly

Figure 2. Two-year old seedling of *Pinus* (Pinus) (Pinus).

greater protection of rainfall into the soil. Conservation of forest
terrace, cross checked by terraces of fifteen to twenty feet by low
earth banks providing a system of shallow basins was another type of
side protection which allowed both moisture and soil conservation.

The technique of actual planting has been variable. On some sites
holes eighteen inches in diameter and as deep or even larger were dug
and filled with surface soil to provide a better medium of growth for
young seedlings planted. The regular practice of digging holes large
enough to accommodate the root system of the type of stock planted has

superseded the other method.

However, of type of stock used, side protection and

low where maintenance measures of cultivation and irrigation have been inadequate. Favorable stands during the first two years following planting have been obtained following thorough cultivation around the plants in the early spring with irrigations throughout the summer and fall when needed.

On many sites, particularly those adjacent to brushy areas, maintenance measures for the control of rodents and rabbits has been absolutely essential for the establishment of satisfactory stands.

Although fire protection has been stressed as a basic^c part of the program for woodland establishment, a fire which occurred on October 8, 1937 burned over 7,000 acres on the project ~~before being brought under control,~~ destroying a large percentage of woodland plantings in addition to native ~~watershed cover, occupying the South Mountain and foothill section.~~

In general in the control of soil erosion on land retired from cultivation and planted to woodland, supplementary soil conservation measures are needed while the trees and shrubs are becoming established. Excluding livestock from the area to encourage voluntary cover and seeding of grasses and legumes such as domestic rye grass, oats, bur clover and sweet clover have been practiced to promote temporary cover.

On several steeply sloping hillside areas retired, level terraces, mentioned previously in connection with site preparation, were constructed before planting to provide temporary control until the trees obtain sufficient growth to protect these areas. Generally this type of construction is economically unfeasible except where very highly valued bottom land lies below.

Treatment of Orchard Land

Although only a small portion of the orchard land has been affected by ~~sheet~~ ^{rainfall} erosion, treatments applied have been important in that they have ^{practically} accomplished complete control ~~of the problem.~~

With the exception of basin listing, soil conserving measures utilized have been adaptations of practices of more progressive operators conducted for soil improvement purposes. These were (1) incorporation of bean straw or damaged legume hay in the fall prior to the winter rains and (2) growing of winter cover crops for green manure. ^{Insertion} The additions to the soils of organic matter by these practices not only maintains favorable conditions for plant growth but also increases the rate of water penetration. Surface runoff is reduced during the winter rainy season and more economic use of irrigation water is obtained during the dry summer ^{season.} Furthermore, the use of winter cover crops protects (Fig. 30) the soil from the beating action of rainfall and keeps the surface receptive to water infiltration.



Figure 30. Winter cover crop in an orange orchard. Soil is conserved and improved; runoff is eliminated.

(Suggest photo of
planted cover
crop)

Treatment of Orchard Land

Although only a small portion of the orchard land has been affected by these studies, treatment studies have been important in that they have demonstrated the need for a more complete control of the orchard. With the exception of basic fertilizers, soil conservation measures utilized have been adequate of operations of soil conservation operations conducted for soil improvement purposes. These were (1) investigation of basic fertilizers or chemical fertilizers in the fall prior to the winter rains and (2) growth of winter cover crops for green manure. The conditions of the soil of orchards under these practices not only maintained a favorable condition for plant growth but also maintained a high level of water conservation allowing more economic use of irrigation water during the dry season and reducing the loss of water during the winter rainy season. Furthermore, the use of winter cover crops protects (Fig. 30) the soil from the baking action of rain fall and keeps the surface responsive to water infiltration.



Figure 30. Winter cover crop in an orange orchard. Soil conserved and improved; results as illustrated.

Beans straw is applied in the late fall or early winter following the first seasonal rain. Rates of application vary from one to three tons per acre. The straw is spread by hand or manure spreading machines and then thoroughly disced into the soil.

Cover crops utilized are of two types: (1) Seeded and (2) volunteer. The seeded cover crops are principally bitter clover, (Melilotus indica) oats, barley, purple vetch and mustard. Bitter clover and purple vetch are legumes with high fertilizing values. Usually the former is seeded alone while the latter is planted in a mixture with either oats or barley. Mustard is also commonly seeded alone.

Volunteer crops consist of a mixture of annual weeds and grass with bur clover. Pigweed, chick weed, small nettle, alfileria, malva, wild oats and annual fescues are some of the more important weeds and grasses volunteering.

In walnut orchards the incorporation of bean straw together with basin listing and cover cropping have given complete protection to soil. Operations for these practices are carried out in the following manner. With completion of walnut harvest in late fall the bean straw is spread and disced into the soil. After the first winter rains the land is basin listed. The cover crop which is usually seeded rather than volunteer is broadcast by hand either before or after the listing operation depending on the size of the cover crop seed. Small seeded species, such as bitter clover are seeded after, while larger seeded cereals, such as oats, barley and vetch, are seeded before basin listing. Seeding attachments are now being devised for the basin lister which will allow the operations to be conducted simultaneously. It has been observed that basin listing without prior incorporation of bean straw or seeding of a cover crop is generally much less effective as an erosion control measure. This has

been particularly true on areas of Group 3 soils of the Rincon series where impermeable subsoils tend to limit moisture penetration. The resultant breakage of basins coincident with water exceeding their reservoir capacity and concentration of runoff causes serious erosion. The effect and damage is still more pronounced with slope increases. On such sites application of bean straw or growing cover crops are required to insure the success of basin listing.

On citrus orchard land the practice of basin listing has not proved feasible for the following reasons: (1) Damage to the shallow root system by the basin listing machine seriously reduces vigor and growth of the trees and (2) the basins interfere with winter orchard operations. Generally the incorporation of bean straw and cover cropping normally practiced have satisfactorily controlled erosion on slopes up to three percent. Cover crops are either seeded or volunteer. During the winter period they are often mowed to reduce interference with other orchard operations. The mowing operation leaves a mulch of vegetation of exceedingly high soil conservation value. On steeper slopes contour planting, bench terracing and cover cropping have provided adequate control in conjunction with mechanical measures such as pipe lines and lined ditches which provide for removal of excess irrigation or rainfall runoff. In established square planted orchards permanent cover in connection with the broad furrow or portable under-head tree sprinkler systems of irrigation is being tried as a means of eliminating irrigation erosion associated with the V type furrow method.

In both citrus and walnut orchards the use of the broad furrow system of irrigation alone (Fig.) has accomplished reductions in irrigation erosion.

Pasture and Range Improvement

During the first year of project operations about 1,000 acres of seeding was done on overgrazed areas in the South Mountain and Foothill Region. Both of these areas are subject to periodic fires which, together with overgrazing have reduced sustained production of protective and palatable forage plants and accelerated erosional process.

Seedings consisted of mixtures of alfileria, needle grass, bur clover, sweet clover, perennial rye grass, and Italian rye grass. Observation during the two years following the seeding indicated that little improvement in the cover was obtained with exception of slight increases in stands of bur clover and alfileria. ~~both of which are native to the area.~~ Very few of the ^{other} introduced species survived beyond the second growing season. Numerous factors were involved some of which were: (1) severity of sites which includes infertile and drouthy soils, (2) competition of native vegetation ^{and naturalized} ~~(3) inadaptability of species to environment~~ (3) ^{apathy of} ~~disinterested~~ farmer compliance on controlled grazing programs and (4) ^{See} ~~dictation~~ lack of fire protection.

Some forage plants which may prove adaptable for these areas are under observation on small plantings. At the present time, however, the lack of adapted species for pasture improvement has necessitated the application of restricted grazing programs as a means of encouraging restoration of ~~native~~ vegetation for soil protection and forage.

Treatment of Idle Land

During the first two years of operations on the project an effort was made to improve the varied woody and herbaceous cover which in portions was insufficient to control soil erosion on ^{the} steep slopes of ~~the~~ South Mountain and upper foothill sections. Because of the extreme severity of the sites resulting in low survival, the lack of facilities for fire protection and the damage to plantings by occasionally wandering livestock further treatment was discontinued.

The fire previously mentioned destroyed all of the work performed in these areas.

On sites of this character, protection from fire and exclusion of livestock will allow pioneer vegetation to become established, provide suitable erosion resisting cover and in time be succeeded by more valuable climax forms.

Wildlife Management

Wildlife management as incorporated into the work of the Soil Conservation Service is essentially a soil conservation program in that it seeks through establishment of erosion resisting vegetative cover the restoration and maintenance of wildlife populations.

Numerous areas that will not support economic types of vegetation such as gullies, bald and severely rilled spots and slips have been specifically dedicated to wildlife by planting desirable types of food ^{cover} and ~~habitat~~ producing plants. In addition to the native species which volunteer, table 20 lists the plants which appear most adaptable for treatment on these sites both for erosion control and wildlife management.

Survival of woody plants has ~~only~~ ^{only} been satisfactory ^{used} when maintenance practices similar to those ~~conducted~~ ^{used} in ~~connection with~~ establishment of woodlands have been followed.

Although a part of these plantings suffered from the 1937 fire, intentional burning of gullied areas, ditches and roadside cuts, adjacent to or within cultivated fields has decreased, resulting in material benefits to food and cover for wildlife as well as soil conservation.

In general all soil saving treatments have contributed something to the wildlife management program. Mechanical stabilization of gullies allowing native vegetation to establish itself, planting of trees, shrubs, herbs and grasses for gully control and the revegetation of land retired from cultivation to pasture and woodland have greatly increased the amount

Table 20. Plants which have indicated their adaptability for areas dedicated to wildlife.

Grasses and Legumes

Sudan grass (<i>Sorghum vulgare</i> var. <i>sudanense</i>)	Soft chess (<i>Bromus mollis</i>)
Perennial rye grass (<i>Lolium perenne</i>)	Elephant grass (<i>Pennisetum purpureum</i>)
Barley (<i>Hordeum vulgare</i>)	Kikuyu grass (<i>Pennisetum clandestinum</i>)
Oats (<i>Avena sativa</i>)	Bur clover (<i>Medicago hispida</i>)
Harding grass (<i>Phalaris tuberosa</i> var. <i>stenoptera</i>)	Sweet clover (<i>Melilotus alba</i>)
Smilo grass (<i>Oryzopsis miliacea</i>)	Purple vetch (<i>Vicia atropurpurea</i>)
Giant wild rye grass (<i>Elymus condensatus</i>)	Alfalfa (<i>Medicago sativa</i>)
Giant reed grass (<i>Arundo donax</i>)	

Shrubs and Herbs

Australian salt bush (<i>Atriplex semibaccata</i>)	Buck brush (<i>Ceanothus cuneatus</i>)
Native saltbush (<i>Atriplex lentiformis</i>)	Coffee berry (<i>Rhamnus californica</i>)
Lemonade berry (<i>Rhus integrifolia</i>)	White leaf buckthorn (<i>Rhamnus Californica</i> var. <i>tomentella</i>)
Sugar bush (<i>Rhus ovata</i>)	Alfileria (<i>Erodium cicutarium</i>)
Laurel-sumac (<i>Rhus laurina</i>)	Burnet (Sanguisorba minor)
Red heart (<i>Ceanothus spinosus</i>)	

Trees

Arizona cypress (<i>Cupressus arizonica</i>)	Black locust (<i>Robinia pseud-acacia</i>)
California pepper tree (<i>Schinus molle</i>)	Siberian elm (<i>Ulmus pumila</i>)
Olive (<i>Olea europa</i>)	Silk oak (<i>Grevilla robusta</i>)
Arizona ash (<i>Fraxinus velutina</i>)	Black wood acacia (<i>Acacia melanoxylon</i>)
Mulberry (<i>Morus alba</i>)	

of territory on farms for wildlife. The agronomic practices of crop rotation, winter cover cropping and improvement of pastures for soil conservation and soil improvement have also been beneficial ^{to} ~~for~~ wildlife.

A phase of the wildlife management program which received considerable attention ^{was} ~~has concerned~~ the control of rodents and rabbits. The damage as the result of diversion of water into tunnels excavated by burrowing rodents in and around dams, terraces and ditches on some locations has necessitated intensive control operations to safeguard this con-

Table 20. Plants which have indicated their adaptability for areas dedicated to wildlife.

Grasses and Legumes	
Bunchgrass (Lophocarpus villosus var. subterminalis) Perennial ryegrass (Lolium perenne) Barley (Hordeum vulgare) Oats (Avena sativa) Hardtail grass (Pennisetum setaceum var. setaceum) Bahia grass (Cynopogon altissimus) Giant wild ryegrass (Lolium cylindricum) Black seed grass (Brachiaria distachya)	Bunchgrass (Lophocarpus villosus var. subterminalis) Perennial ryegrass (Lolium perenne) Barley (Hordeum vulgare) Oats (Avena sativa) Hardtail grass (Pennisetum setaceum var. setaceum) Bahia grass (Cynopogon altissimus) Giant wild ryegrass (Lolium cylindricum) Black seed grass (Brachiaria distachya)
Shrubs and Herbs	
Black brush (Scaevola taccada) Coffee berry (Rhamnus californica) White leaf buckwheat (Eriogonum fasciculatum) California poppy (Eschscholzia californica) Allertonia (Eriogonum fasciculatum) Burdock (Arctium lappa)	Australian salt bush (Atriplex canescens) Native saltbush (Atriplex confertifolia) Lammont berry (Rhamnus californica) Sugar bush (Ficus ovata) Lammont berry (Rhamnus californica) Red heart (Gutierrezia serotina)
Trees	
Black locust (Robinia pseudo-acacia) Almond (Prunus amygdalus) Silk oak (Grevillea robusta) Black wood acacia (Acacia melanocoryne)	Arizona spruce (Picea arizonensis) California poplar (Populus monilifera) Olive (Olea europaea) Arizona ash (Fraxinus velutina) Monterey (Pinus sabiniana)

of territory on farms for wildlife. The extensive practices of crop rotation, winter cover cropping and improvement of waters for soil conservation and soil improvement have also been beneficial for wildlife.

A phase of the wildlife management program which received considerable attention has been the control of rodents and rabbits. The success in the control of diversion of water into tunnels excavated by burrowing rodents is and around them. Traps and ditches on some local farms has necessitated intensive control operations to reduce this

struction. On bare or cultivated slopes burrowing animals are ^{sometimes} often a contributory factor in soil erosion. Water concentrating in these burrows starts gullies or causes established gullies to branch or finger. Depredations to vegetation through eating roots, leaves and stems, and girdling trunks (Fig. 31) and branches of woody species has been import-



Figure 31. Two year old Eucalyptus tree girdled by rodents. Young trees are especially susceptible to attack.

ant in reducing the effectiveness of vegetative control measures.

Efficacious methods employed in the control of rodents have been poisoning, fumigation and trapping. Mechanical protectors around trees ^{have} has prevented damage by rabbits and mice. Tar paper wrappers have been extensively used for this purpose.

Prior to July 1, 1937 the rodent control operations were conducted

Abstract

attention. In bare or cultivated slopes burrowing animals are often a contributory factor in soil erosion. Water concentrating in these furrows starts gullies or causes established gullies to deepen or widen. Perforations in vegetation through eating roots, leaves and stems, and similar damage (fig. 31) and branches of woody species has been reported.



Figure 31. Two-year old Eucalyptus trees killed by rodents. Young trees are especially susceptible to attack.

and in reducing the effectiveness of vegetative control measures. Efforts have been made to control the control of rodents have been poisoning, trapping and shooting. Mechanical protectors around trees has prevented damage to trunks and stems. For paper protectors have been extensively used for this purpose. Prior to July 1, 1937 the rodent control operations were conducted

by the Soil Conservation Service in cooperation with the Federal Biological Survey and county agencies. Since that date the responsibility for (this) (phase of) control work has been an obligation of the cooperator. Technical advice has however been rendered when needed.

Fertilization

Fertilizers in the erosion control program serve three primary purposes: (1) Provide a fertile seed bed to facilitate establishment of agronomic and vegetative erosion controls on infertile eroded sites; (2) force rapid and early vegetative growth of grasses and herbaceous plants so that a maximum cover will be obtained in time to give ^{good}~~maximum~~ soil protection and (3) increase the density of cover and thereby afford more adequate protection against soil erosion.

Observations on the effect of commercial simple and complete fertilizers and manures indicates, that in general, applications of nitrogenous simple fertilizers such as amonium sulfate and calcium nitrate gave the most nearly desired results. On severely eroded sites, where the objective was to establish an early dense growth of grasses regardless of its utility for forage, applications equivalent to 100 pounds of nitrogen ^{per acre} (8) proved satisfactory. On slightly to moderately eroding ^{ed}~~ing~~ areas being planted to annual or permanent grasses for hay or pasture 20 to ⁶⁰~~40~~ pounds of nitrogen (equivalent to 100 to 200 pounds of amonium sulfate, 20 percent nitrogen) has obtained good results.

¹⁷
(8) 500 pounds of amonim sulfate analyzing 20 percent nitrogen or comparable fertilizers.

Investigational Studies

Investigational studies conducted in connection with the demonstrational program consists of (1) watershed studies and (2) forage plant adaptation studies.

In work of this nature the variability of seasonal conditions has necessitated continuance of these studies beyond the five year period of project operations in order to establish significant results.

Watershed studies. The watershed studies program is being carried on in cooperation with the Research Division of the Soil Conservation Service.

The purpose of these studies is to determine the amount of runoff resulting from rainfall on typical watersheds representative of the physiography and agriculture of the area. The data obtained will give more accurate information on runoff for use in design of future erosion control measures.

The program is being conducted on five watersheds ranging in size from 45 acres to 400 acres. The runoff from each watershed is measured by a runoff station consisting of a triangular broad crested weir equipped with an automatic water level recorder. The stations are located in the main drainage channels of the watersheds at points where the total runoff can be measured. Rainfall is measured by two or more automatic recording rain gauges located at strategic points on each watershed. In addition to these stations, the project has had in operation three runoff measuring stations and four recording rain gauges which supplement the watershed studies installations.

It is anticipated that the information gained through these studies will be applicable not only to the section ^{ed by} ~~representative of~~ the project area but also ^{in some degree} the entire south coastal region of California.

Allied with watershed studies is a regional program to determine the

rainfall patterns throughout the state. Through the cooperation of private agencies the project is maintaining six recording rain gauges located within a radius of three hundred miles of the project.

Forage plant adaptation studies. The purpose of these studies has been to determine the adaptability of a number of introduced forage species which have proved desirable erosion control plants in sections where environmental conditions are somewhat similar to those existing on the Las Posas area. Two factors were considered in carrying on these studies: (1) the adaptability of the plants to the climate and soils of the area, and (2) the ability of the plants to survive in competition with ^{established} ~~native~~ vegetation. Information on these points was a necessary first step before further use of the plants could be made in pasture, range, and other vegetative erosion control programs.

In conducting the studies six plots were established on representative sites. Of these three remain on which seasonal observations are being recorded, the others having been discontinued - two because of excessive weed competition and one following accidental removal by the cooperating farmer. All plots were set out on clean cultivated land and allowed thereafter to endure the competition of volunteering vegetation.

Table 21 gives a summary of plant survival based upon a composite of general observations made since the establishment of the plots. The information presented should be considered as preliminary - the period of observation being too short for final conclusions.

Evaluation Studies

← What about
Experimental Farm?

Evaluation studies have been conducted as part of the operations program to determine the effectiveness of applied soil conservation treat-

Table 21. Survival observations on forage plant adaptation plots (1)

Plant Name	Life Period(2)	Survival (3)		
		Plot 1	Plot 2	Plot 3
Sulla clover (<i>Hedysarium coronarium</i>)	Per			P
Manganese clover(<i>Medicago arabica</i> var.)	An			F
Egyptian clover (<i>Trifolium alexandrinum</i>)	Per			N
Ladak alfalfa (<i>Medicago sativa</i>)	Per			F
Western wheat grass (<i>Agropyron smithii</i>)	Per			P
Tall meadow oat grass (<i>Arrhenatherium elatius</i>)	Per			P
Velvet grass (<i>Holcus lanatus</i>)	Per			N
Smooth brome grass (<i>Bromus inermis</i>)	Per	P	F	P
Crested wheat grass (<i>Agropyron cristatum</i>)	Per	F	P	F
Rhodes grass (<i>Chloris gayana</i>)	Per	P	P	F
Meadow fescue (<i>Festuca elatior</i>)	Per	N	N	N
Sheeps fescue (<i>Festuca ovina</i>)	Per	N	N	
Smilo grass (<i>Oryzopsis miliacea</i>)	Per			G
Harding grass (<i>Phalaris tuberosa</i> var. <i>stenoptera</i>)	Per	F	E ?	F
Bulbous blue grass (<i>Poa bulbosa</i>)	An			P
Burnet (<i>Sanguisorba minor</i>)	Per	F	G	G
Italian rye grass (<i>Lolium multiflorum</i>)	Per	P	F	P
Sacaton (<i>Sporobulus wrightii</i>)	Per			N
Desert needle grass (<i>Stipa speciosa</i>)	Per			N
Purple needle grass (<i>Stipa pulchra</i>)(4)	Per	E	E	
Sudan grass (<i>Sorghum vulgare</i> var. <i>sudanense</i>)	An			E (5)
Perennial rye grass (<i>Lolium perenne</i>)	Per	P	F	
California melic (<i>Melica imperfecta</i>)(4)	Per	P	F	
Native clover (<i>Trifolium gracilentum</i>)(4)	An			F
Native clover (<i>Trifolium ciliatum</i>)(4)	An			F

- (1) Plot 1: Seeded - Jan. 27, 1935; soil - Rincon clay loam; slope - 38%.
 Plot 2: Seeded - Jan. 27, 1935; soil - Panoche clay loam; slope - 4%.
 Plot 3: Seeded - Nov. 27, 1935; soil -Altamont clay loam; slope - 40%.
 (2) Per - perennial; An - Annual.
 (3) E - excellent; G- good; F - fair; P - poor; N - no survival.
 (4) Native species for comparisons.
 (5) On cultivated land only.

Plot 2 was subjected to intermittent grazing during the spring of the first two years without noticeable effect upon the growth of plants. All seemed to be grazed about equally as well, except purple needle grass, which was untouched apparently because of its harsh herbage.

ments. The information which is gathered through observation in the field, particularly during storms of the winter rainy season, has been the basis of improvements in the design and installation of erosion control structures as well as in application of other soil conserving practices involving agronomic and vegetative treatment. Previous sections dealing with soil saving treatments have been largely based upon evaluation information.

Coordination of Treatment

Previous sections on soil conservation treatments have dealt with the mechanics of erosion control from the standpoint of applications accorded various phases of the problem. In actual operations the objective has been to establish on individual cooperator farms, soil and moisture conservation programs so coordinated and applied as to not only meet the specific needs of soils, slopes and erosion conditions but also economics of land utilization. ✓

An illustration of an established coordinated program is represented in Figure 32 (B) which depicts reorganized land use and treatments applied to an individual farm on the project area as carried out by the cooperating farmer with the assistance and advice of the Soil Conservation Service in accordance with a plan of conservation operations agreed upon by both parties. ~~It will be recalled that the plan of conservation operations is an integral part of the cooperative agreement - which sets up contractual relationship between the farmer and the Federal Government for a period of five years. During this period the cooperating farmer agrees to comply in maintaining for demonstrational purposes the program form-~~

~~ulated and set forth in the plan of conservation operations following its initial establishment.~~ Figure 32 (A) shows prior land use, soils, slopes and erosion conditions. A summary of land conversions accompanying reorganized land use is given in Table 22 .

The farm embraces 245.85 acres and consists of a number of small watersheds and parts of several larger ones originating north and west on contiguous properties. The topography is typical of the Foothill Region of the project area with relatively steep slopes arising from dissecting gently sloping valleys.

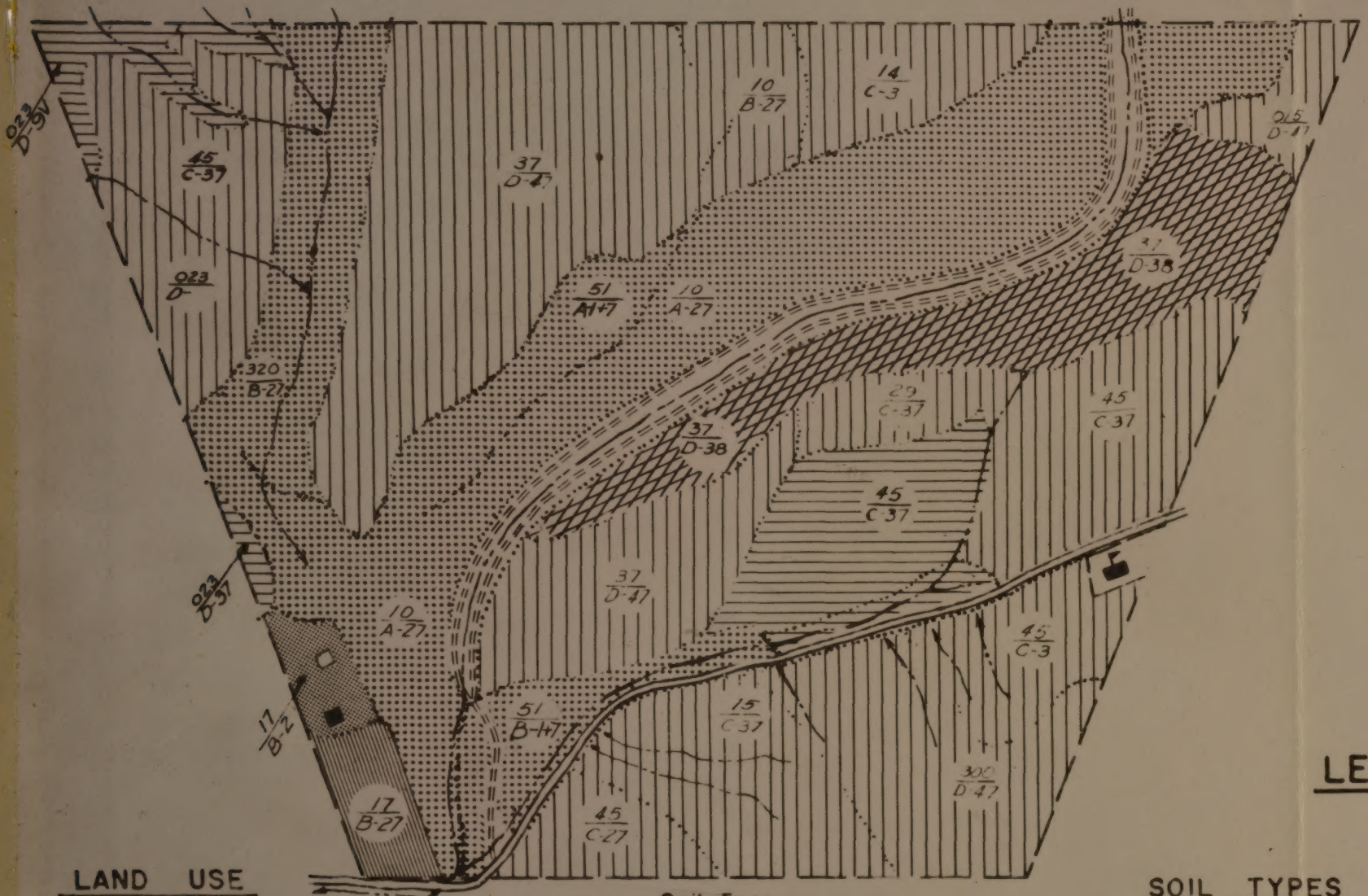
Soils are extremely variable. With the exception of valley land soil types - Sorrento clay loam, Panoche clay loam and Yolo loamy sand, the remainder are highly susceptible to erosion. Slopes range from less than 2 percent to as high as 60 percent.

The practices accompanying the culture of beans over a nearly quarter of a century has given rise to severe erosion on hillsides and deposition on portions of the valley land of infertile erosional material. Slopes between 10 percent and 25 percent have generally lost from 25 percent to 75 percent of their topsoil. Steeper slopes have been subjected to still greater removals. In some places the losses include all of the topsoil and part of the subsoil. Gullying has also been severe, both on the hills and valley land. The vertically walled drainway-way gully lying between the two paralleling farm roads adjacent to the walnut orchard varies from ten to forty feet in depth and averages twenty five feet in width. Recession of the channel grade has led to undercutting of the banks with subsequent sloughing, engulfing areas of orchard land. Furthermore, runoff from bordering hillsides has cut occasional gullies through the lower lying orchard land which have served to accelerate erosional processes.

Figure 32 Sketch maps of an actual farm showing changes in land use and treatments applied in establishing a coordinated soil conservation program.

(A.) Prior land use, soils, slopes and erosion.

(B.) Reorganized land use and soil conserving treatment.



LEGEND

LAND USE

- Walnuts.
- Beans.
- Citrus.
- Pasture.
- Idle land.
- Farmstead.

Slope

- A=0-2%
- B=2-10%
- C=10-25%
- D=Above 25%

Soil Type
Slope - Erosion

Erosion

- 1=Recent Deposition.
- 2=Under 25% removed.
- 3=Between 25-75% "
- 4=Over 75% "
- 7=Occasional gullies.
- 8=Frequent "
- 9=Destroyed by "

SOIL TYPES

- 10 - Sorrento clay loam
- 14 - Altamont silty clay
- 15 - Rincon clay loam
- 015 - " " (Dark phase)
- 17 - Panoche clay loam
- 023 - Altamont loam
- 37 - " clay loam
- 45 - Huerhuero loam
- 51 - Yolo loamy sand. (Sorrento subsoil phase.)

LAND USE

- Walnuts with winter cover crop.
- Citrus with winter cover crop.
- Crop rotation and contour cultivation.
- Pasture.
- Woodland and Wildlife.
- Farmstead.

IMPROVEMENTS

- Masonry Dams.
- Concrete Dams.
- Ditches and Dikes.
- Terraces.

Table 22 Summary of land conversions accompanying reorganized land use.

Prior land uses	Before treatment	Reorganized land use after treatment.						
		Annually Cropped Rotations.	ORCHARD		Pasture	Woodland and Wildlife.	Idle	Farmstead.
			Walnuts	Citrus				
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Annually cropped (beans)	127.23	37.22						
Orchard (walnuts)	73.52		73.52					
Orchard (citrus)	3.42			24.20				
Pasture	23.72				97.24			
Woodland and Wildlife						11.53		
Idle	15.82							
Farmstead	2.14							2.14
Total acreage	245.85	37.22	73.52	24.20	97.24	11.53		2.14
Net changes		-90.01		+20.78	+73.52	+11.53	-15.82	

The practices of clean cultivation during the winter has also contributed to soil losses on the orchard land even though slopes on the greater portion are less than 2 percent. In the north western part of the farm an area of about 4 acres once cropped to beans has been entirely destroyed by gullies. A large field type gully paralleling the east-west road arising some distance below the school house has developed as the result of concentration of runoff from the cultivated field above. Erosional material washed out of this gully has spread over approximately 13 acres of rich orchard land directly below.

The hillside in pasture was at one time cropped to beans. Severe sheet and gully erosion brought about its voluntary retirement.

In the application of soil conserving treatments (Figure 32)(B), as set forth in the plan of conservation operations, the greater portion of the steeply sloping cultivated hill land above 25 percent has been retired to permanent pasture under a controlled grazing program. On other slopes of this character remaining in cultivation, contour farming, crop rotation and terrace systems have been established. The crop rotation consists of one year of hay followed by two years of beans.

Portions of previously annually cropped land lying on lesser slopes (B and C slopes) have been diverted to citrus production with trees planted on the contour and cultivation practices being followed which will ultimately result in the formation of a system of bench terraces. Prior to setting out the citrus orchard in the southern part of the farm a series of narrow base terraces were installed as a temporary means of assisting in checking runoff until the bench terraces were developed. All orchards are cover cropped during the winter. In addition the walnut orchard is basin listed. Dikes have also been constructed in the walnut orchard to subdivide and divert surface runoff water in the event of high intensity

storms under which runoff from the adjacent hillsides and contiguous watersheds on adjoining properties might cause severe gullying.

Gullies have been controlled by both structures and vegetation. A series of dams were constructed in drainage way gullies and larger field gullies to stabilize the channels. The field gully which serves as an outlet for the terraces constructed on the field north of the school house has been entirely controlled by vegetation. Kikuyu grass was planted in the flow line and various woody plants along its sides.

Woodland wildlife plantings have been made on severely eroded sites on the farm. Vegetation used in gully control plantings have been selected particularly for wildlife benefits.

The plan of conservation operations in effect on this farm exemplifies the coordinated method of treatment. Erosion resisting types of land usage have been correlated and coordinated with practices and measure designed not only to prevent or minimize further accelerated erosion but also to improve the soil with resultant economic benefits in long time use of the land.

Educational Activities

In outlining the purposes to be served by soil conservation projects it was stated that education of the public and training of technicians were among the fundamental objectives of the program.

Educational activities, through which the public in this section has gained a recognition of the problems of soil erosion and an understanding of methods of soil conservation, have involved (1) presentation of illustrated lectures and motion pictures on (the subject (matter) of) erosion and its control from both a local and nationwide standpoint, (2) radio address

(3) newspaper releases, (4) exhibits at local city and county fairs, (5) group discussions and (6) tours of the project area.

Tours of the project area have been particularly important in developing interest in the program among farmers from surrounding communities and other visiting agricultural groups. On these tours technicians discuss various phases of the erosion problem illustrating their solution by pointing out actual working demonstrations installed or being practiced on farms of cooperators.

These educational programs have been sponsored by or conducted in cooperation with such organizations and agencies as the California Agricultural Extension Service, county farm bureaus, 4-H clubs, city and county fair committees, parent-teachers associations, high schools and colleges, community newspapers, local radio stations, service clubs and other social organizations.

From its inception as the first soil conservation demonstrational project in California, the Las Posas project has served as a training center for technicians who have later been assigned to carry on erosion control activities on other projects in the California-Nevada region. This training consisted in equipping men trained in specialized fields of the agricultural profession with the necessary actual experience so that their expert knowledge was correlated with the varied activities required in planning and establishing sound soil and water conservation programs. Thus the agronomist, engineer, forester, soils experts, biologist and farm management expert are able to collaborate on a basis of common understanding in developing coordinated erosion control programs.

ACCOMPLISHMENTS AND RESULTS

On most soil conservation demonstrational project areas from two to two and one-half years have been the usual period of full activity or as it is officially designated - the operations period. During this time plans and applications of treatments are established on a sufficient number of farms to provide a good demonstration in the area. The remainder of the five year agreement period or the maintenance period, conducted by a reduced staff, is devoted to advising, aiding and encouraging cooperating farmers and others in the area to follow their program in the most accurate manner possible.

On the Los Posas project area the complexities of the problems associated with soil erosion and land utilization has necessitated the continuance of full operations for the entire five year period. Even this lengthy period has, however, left major unsolved problems requiring a detailed research program for ultimate solution.

Degree of Program Establishment

During the period between January 12, 1934 and January 12, 1939, covering the five years of project operations, 105 farms, or 38 percent of the total ~~farms numbering~~ ^{farms} 280[^] within the project area, were signed under cooperative agreement with the Soil Conservation Service. The cooperative agreement farms included 18,033 acres or 48 percent of the total area of 37,490 acres in farms on the area. The actual total area of the project embracing 38,488 acres included 37,490 acres in farms and 998 acres in roads and suburban residential homesites of less than 3 acres. No cooperative agreements were signed on residential property. For statistical purposes, therefore, the 998 acres have been excluded in the analysis of accomplishment data.

Of the total 105 cooperative agreements signed, four were canceled. Of those canceled one was resigned leaving a net of 102 agreements embracing 17,676 acres at the close of the operations period. Table 23 summarizes the degree of program establishment on the project area during this period.

Table 23 - Degree of program establishment

	No. of farms	Per- cent	Acres	Per- cent
Total farms in project area	280	100.0	37,490	100.0
Total project area requiring soil conservation treatment	280	100.0	37,490	100.0
Cooperative agreements signed	105	37.5	18,033	48.1
Cooperative agreements in force(1)	102	36.4	17,676	47.1
Total project area under agree- ment receiving soil conservation treatment	105	38.0	15,384	41.0
Coordinated programs established	39	10.4	1,974	5.3

(1) As of January 12, 1939

All land in farms within the project area required soil conservation treatment either in the form of continuation and refinement of established practices or application of new measures. The acreage receiving treatment on cooperative agreement farms totaled approximately 15,384 acres which is 41 percent of the total project area and 87 percent of the acreage in farms under cooperative agreement. Although all cooperative agreement farms received some treatment coordinated programs were established only on 29 farms embracing a total of 1,974 acres.

Table 24 gives a summar⁴ization of (1) the potential amount of soil

conservation treatments and practices applicable on cooperative agreement farms as set forth in plans of conservation operations of all cooperative agreements in force, (2) the actual amount of treatments and practices established as determined by compliance records and field surveys and (3) the percentage accomplishment of actual amount of treatments and practices established with reference to potential amounts.

Table 24 - Treatments and practice establishment

Treatment or Practice	Unit	Poten- tial amount	Actual amount	Percent accomp- lishment
Contour cultivation	Acres	7,317	4,988	68
Strip cropping	Acres	2,591	-----	--
Terracing	Miles	91	35	39
Terraces	Acres pro- tected	1,955	1,012	52
Winter cover crops	Acres	2,264	1,852*	82
Basin listing	Acres	183	465*	254
Approved rotations	Acres	1,289	1,176*	92
New pasture range	Acres	1,149	966	84
Controlled grazing	Acres	173	-----	--
Wildlife areas	Acres	437	36	8
New woodlands	Acres	504	56	11
Annual ditch systems	Acres	127	117*	92
Diversions	Lin.Ft.	36,322	22,857	63
Gully structures	Numbers	1,490	1,099	74
Outlet structures	Numbers	354	316	89
Improved irrigation methods	Acres	332	302	91

* Figures for 1938 only

The actual amount listed in Table 24 for terraces, wildlife areas, woodlands, gully and outlet structures is less than that originally established inasmuch as the data represents existing conditions in the field at the close of the operations period and excludes all losses which have occurred since the inception of the work.

Reflecting the inadaptibility of strip cropping is the zero percent accomplishment for this practice.

Although from the standpoint of acreage treated basin listing has been of relatively minor importance the high percentage accomplishment indicates recognition of its benefits for erosion control. In 1938 more than 2,000 acres of cropland, principally walnut orchard land, located on non-cooperator farms within the area and farms outside of the project were basin listed.

Notwithstanding that approved rotations actually established nearly equals the potential amount set up in cooperative agreements it should be pointed out that this acreage represents only 12 percent of the total crop land on cooperative agreement farms ^{that should have} ~~subject to~~ rotational programs. The small portion of cropland with soil conserving rotations discloses the existence of a major unsolved problem.

Cooperation.

An analysis of compliance and adoption of soil conservation treatments and practices on the 102 cooperative agreement farms discloses that good cooperation has been obtained on 52 percent of the farms covering 35 percent of the total agreement acreage; fair cooperation on 20 percent of the farms and 24 percent of the agreement acreage and poor cooperation and non compliance on 29 percent of the farms which includes 41 percent of the total agreement acreage. Table 25 summarizes the degree of cooperation. In this

Table 25. Classification of cooperative agreement farms by type of operator and type of cooperator

Type of operator.	Type of cooperator																Total farms by operators.			
	GOOD (1)				FAIR (2)				POOR (3)				NON-COMPLIERS (4)							
	No.	Per-	Per-	No.	Per-	Per-	Per-	No.	Per-	Per-	Per-	No.	Per-	Per-	Per-	No.	Per-	Per-	Per-	Per-
	of farms	cent	Acres	of farms	cent	Acres	cent	of farms	cent	Acres	cent	of farms	cent	Acres	cent	of farms	cent	Acres	cent	cent
Owner	37	75.5	2,999	54.2	6	12.2	979	17.7	4	8.2	1,235	22.3	2	4.1	324	5.8	49	100.0	5,537	100.0
Manager	8	36.4	1,644	34.0	5	22.7	1,313	27.2	6	27.3	1,404	29.0	3	13.6	473	9.8	22	100.0	4,834	100.0
Tenant	8	25.8	1,499	20.5	9	29.0	1,971	27.0	7	22.6	1,901	26.0	7	22.6	1,934	26.5	31	100.0	7,305	100.0
TOTAL	53	51.9	6,142	34.7	20	19.6	4,263	24.1	17	16.7	4,540	25.7	12	11.8	2,731	15.5	102	100.0	17,676	100.0

(1) Doing 75 percent or more of what they agreed to.

(2) Doing between 50 and 75 percent of what they agreed to.

(3) Doing between 25 and 50 percent of what they agreed to.

(4) Doing less than 25 percent of what they agreed to.

connection it is estimated that on 60 farms or 59 percent of those under agreement embracing 8,235 acres or 47 percent of the agreement acreage cooperation may be expected to continue beyond the expiration dates of the cooperative agreements indicating the extent to which soil conservation treatments have become part of the farm program.

Of the three types of operators, tenants have been the poorest co-operators. On 45 percent of the farms and 53 percent of the acreage operated by tenants the degree of cooperation has been classified as poor or less.

On the greater portion of the cooperative agreement farms operated by managers or owners good or fair cooperation has been the rule.

An underlying cause for the high percentage of poor cooperators and non-compliers on tenant operated farms is the casual interest these operators have in the land. Customarily tenants operate the land on a crop share basis with a year to year lease. Although this type of contractual relationship allows the land owner to easily rid himself of an undesirable operator it also deters the tenant from taking a permanent interest in improvement and economic utilization of the land. Under these circumstances immediate profit motivates every action of the tenant. Necessary measures for soil conservation and soil improvement are sacrificed since the tenant has ^{assurance} ~~no security~~ that the benefit of expenditures for such practices will accrue to him in future years.

Thus notwithstanding that both the owner and tenant agreed on the plan of conservation operations for the farm and sign a cooperative agreement the insecurity of tenure make the tenant a reluctant cooperator.

Another cause which includes all classes of operators of cooperative agreement farms and especially those located on the hill lands has been the influence of depression economic conditions. Lower prices for agricultural

products have been reflected in the price received for lima beans. Due to this condition many operators have delayed carrying into practice soil conservation measures because of the fear of increased expenditures and possible reduction in the decreased returns.

Changes and Trends in Land Use, Erosion,
Economic and Social Conditions.

*If true!
A sad, but significant
fact, which might have
had less prominence*

There has been little change in the ~~usage~~^{use} of land during the five year demonstrational period, which would fundamentally alter the pattern from that existing at the inception of project operations. A number of critically eroded areas previously annually cropped to beans and located principally in the Foothill Region of the project were abandoned to permanent vegetation during this period. It is estimated that about 2 percent of the total crop land devoted to beans has been affected indicating an alarming rate of soil destruction and a serious misuse of land.

Orchard plantings, principally citrus, have displaced beans on approximately 5 percent of the irrigated crop land. Several small citrus plantings have also been made on sloping dry farmed land following the development of water supplies. Here contour planting or bench terracing with winter cover cropping have provided admirable ~~usage~~^{use} of soils highly susceptible to erosion under the previous type of culture. That any considerable portion of the dry farmed land will be diverted to citrus is, however, ~~problematical~~^{doubtful?}. The availability of water and its cost of development together with the present economic conditions in the citrus industry are factors fundamentally ~~modifying~~^{limiting} future expansion.

The changes in land use which have accompanied the establishment of soil conservation programs on cooperative agreement farms is shown in Table 26. The major conversion has been in annual crop land where 1,185

acres have been diverted principally to more erosion resisting pasture usage. This exceeds the 934 acres of crop land scheduled for retirement under cooperative agreements by more than 13 percent. In this connection the decrease in clean tilled crop land is 1,376 acres or 28 percent more than ^{the} what cooperators originally agreed to do.

Table 26. Land conversions on cooperative agreement farms.

Before Treatment	After Treatment (1)					
	Crop land		Woodland wildlife		Other land	
Acres	Acres	Acres	Acres	Acres	Acres	Acres
Annually cropped land	10,402	9,099	128	823	12	340
Orchard	2,531	24	2,459	28	8	12
Pasture	3,038	92		2,794	1	151
Woodland-Wildlife						
Other land (2)	1,705	2		359	71	1,273
Acres in agreements	17,676	9,217	2,587	4,004	92	1,776
Net changes	--0--	- 1,185	+ 56	+ 966	+ 92	+ 71

(1) Actual figures as of January 12, 1939

(2) Includes idle land and farm steads.

Control of erosional processes associated with gullying and channel degredation have been successfully demonstrated on a large scale under all types of land use and watershed conditions. Most drainage-way channels have been partially or completely stabilized with resultant siltation raising channel levels and preventing further serious encroachment on adjacent crop lands. Headward erosion of gullies has been stopped by water diversion measures. Field gullies have been controlled and the threat of erosional

There have been diverted initially to more erosion resistant pasture
lands. This exceeds the 854 acres of crop land scheduled for retirement
under cooperative agreements by more than 18 percent. In this connection
the decrease in cropland from 1940 to 1954 is 1,046 acres or 18 percent more
than what cooperative originally agreed to do.

Table 20. Land conversion, by cooperative
agreement, 1940-1954.

Before treatment		After treatment (1)	
Acres	Percent	Acres	Percent
Annually cropped land	10,408	9,030	13.4
Forest	2,551	2,489	2.4
Barren	2,039	2,794	1.1
Woodland-grassland			
Other land (2)	1,408	2	VI 1,243
Acres in agreement	14,006	2,004	22 1,478
Net change	-1,185	2,004	22 1,478

(1) Total figures as of January 12, 1955
(2) Includes this land and other lands.

Control of erosion processes associated with logging and other
disturbance have been successfully demonstrated on a large scale under all
types of land use and vegetational conditions. Good drainage-way channels
have been initially or completely eliminated with resultant
reduction of erosion hazard and prevention of further serious encroachment on adjacent
lands. Substantial erosion of gullies has been stopped by water diversion
and other measures.

debris thereby eliminated.

On orchard land all phases of control of accelerated erosion have been successfully demonstrated and are receiving widespread application. Generally these have been extensions of proven practices of more progressive orchardists.

On annually cropped land progress in adoption of soil conservation measures has been slow. Practices uncommon to this section have had to be recommended to meet the needs of the situation. Farmers have been skeptical of new practices especially where the old ones yielded satisfactory returns in spite of soil losses. An example of this is well illustrated in the following paragraph.

Since establishment of the project as a demonstrational area in 1934, the Soil Conservation Service has recommended the return of bean straw to the crop land ^{on} from which it was produced. Farmers claimed it would increase the wire worm (*Limoni* *californicus*) population in the soil and cause serious reduction in crop yields. Most of the straw was baled and sold to orchardists who spread it in their citrus and walnut orchards for soil improvement. The remainder was fed to livestock or workstock. In 1937 the pick-up type threshing machine, at present adaptable to flat land, was first used on the project area replacing the usual stationary thresher with its numerous wagons, labor load and greater cost in harvesting. The pick-up type thresher returned the straw to the land. During subsequent seasons the acreage harvested in this manner increased rapidly with the prospects that shortly all the flat land beans will be harvested with the pick-up type thresher. On some fields threshed by the old method, farmers are now spreading the piled straw. No reports of decreased yields have been made. ✓

Although incorporation of crop residues has a beneficial effect for soil improvement additional measures are needed for adequate soil conservation. Where the diversification of farm enterprises has allowed the introduction of soil conserving rotations (page 110) erosion control on the crop land has been established. Few farms are, however, susceptible to this type of treatment. Although terraces have been of great benefit in preventing gully formation and deep contour tillage practices such as subsoiling, chiseling and deep plowing in partially reducing sheet erosion accompanying early winter precipitation, effective erosion control measures compatible with continuous bean cropping yet remain to be developed.

Economic and social conditions have remained unchanged since the inception of the project.

Unsolved Problems.

The major unsolved problem is concerned with accelerated erosion occurring with high-intensity storm during the winter rainy season on clean-tilled, winter-fallow, sloping land, annually cropped to beans each summer.

The economy of the entire agricultural structure on annually cropped lands has been developed in the course of the past quarter-century in association with continuous bean culture. As an outgrowth of this, economic factors involved in investment-overhead, size of farm and farm tenancy have prevented the establishment, on most farms, of a satisfactory control program by methods other than with the utilization of beans as an annual cash crop. Furthermore, the reluctance of farmers to substitute unproven enterprises for beans, while a chance for favorable profits still existed, contributed to the continuance of the established system. Only when the surface soil becomes to severely eroded that insufficient amounts remain ✓

to prepare a seed-bed are the farmers willing to change practices.

During the early period of project operations, a system of winter cover-cropping and incorporation of crop residue was recommended as the most effective program for the control and further prevention of accelerated soil erosion occurring under clean-tilled winter fallow practices. This recommendation met with immediate disfavor in the field. Farmers claimed that such a program would interfere with the production of the subsequent bean crop. These claims were based upon the following points:

1. The utilization of soil moisture by the winter cover crop would reduce the amount available for the summer-grown bean crop, thereby effecting a serious decrease in yields. (The winter-fallow practices, under which the acceleration of erosional process has occurred, were developed principally for moisture conservation and weed control.)
2. Incorporation of quantities of organic matter would interfere with seedbed preparation.
3. The poor distribution of rainfall might cause a situation in which the soil becomes too dry for effective incorporation of cover crops with the resulting loss of a season's bean crop.
4. Wire worms (*Pheletes californicus*), due to the possible incompletely incorporated organic matter, would increase in population, with the resulting damage to the subsequent bean crop, a condition which has been neither proved nor disproved.

The added cost of operations connected with the winter protective measures was also an important consideration especially under the existing farm tenancy situation where the tenant is a year-to-year lessee with only a casual interest in long-time benefits. The scope of this problem is more clearly realized when it is considered that tenants operate 55 percent of all the hill land farms which total 18,477 acres or 49 percent of the entire project area. As a result of farmer disapproval, due to the factors mentioned, this line of attack was temporarily discontinued.

This entire problem is on the investigational docket of the Somis Experimental Farm which was established during 1938 by the Soil Conservation Service in conjunction with the California Agricultural Experiment Station for the express purpose of establishing standards for the control of soil erosion on this category of land.

Another problem nearly equal in importance to that existing on sloping annually cropped land concerns the South Mountain section of the project where severe overgrazing and consecutive burning have removed watershed cover accelerating runoff and erosional process.

Control measures recommended for this area were rotational grazing and fire protection. Neither of these practices have become established. In some instances deferred grazing has been practiced. This has partially eliminated the problem through increased vegetative cover. On the whole, however, range management practices have not been accepted mainly due to economic and physical factors involved in annual leases, small units, lack of water and the fact that the land is being held more or less speculatively for oil. Lack of water has been a particularly important factor in this problem. Water restricts usage for grazing to the spring period. Furthermore, as most of the grazes on this area are annuals of

low erosion resisting character becoming unpalatable in the summer, severe grazing is carried on during the spring period in order to make the most out of the short period during which forage is palatable. During the winter rainy season the low erosion resisting value of these annual covers are of little importance in checking runoff and erosion.

The introduction of some plants which will replace the unpalatable annual grasses of low erosion resisting character will aid materially both in better land ^{use} ~~usage~~ and more effective soil conservation. This together with the consolidation of small units, development of water and long term leasing with managed grazing and fire protection would possibly solve the problem. 7

RECOMMENDATIONS

In previous sections the various treatments and practices for the control of soil erosion have been discussed from the standpoint of application and evaluation. Inasmuch as one of the objectives of a demonstrational project has been to develop recommendations applicable to land representative of the project area, it is the purpose of the present section to formulate in a generalized manner these recommendations.

Primarily the ^{use} ~~usage~~ of land is based upon its inherent soil characteristics and climatic environment which in turn governs its capabilities for productive utilization. According to use capabilities of the land, 5 classes have been established for general recommendations. In brief, the classes designate land (1) suitable for cultivation without special practices, (2) suitable for cultivation with simple practices, (3) suitable for cultivation with complex or intensive practices, (4)

unsuitable for continuous cultivation and (5) unsuitable for cultivation. These classes indicate the most intensive utilization that is consistent with the preservation of the soil.

Class 1 land is land that from the standpoint of inherent characteristics and environmental features can be cultivated permanently with the production of moderate to high yields of adapted farm crops without special soil conserving practices or measures.

In order to be cultivated safely and permanently with the production of moderate to high yields of adapted farm crops, class 2 land requires one or more special soil conserving practices.

In class 3 the inherent soil characteristics and environmental features requires complex or intensive measures for safe and permanent cultivation of the land with production of moderate to high yield of adapted farm crops.

Classes 1, 2 and 3 include all lands that can be recommended for regular cultivation. Land of classes 2 and 3 are characterized by one or more of at least three different sets of factors: (1) susceptibility to erosion if cultivated, (2) physical obstacles such as hard pan or poor drainage and (3) low productivity requiring special soil improvement practices other than those common to the locality in order to obtain production of at least moderate yields of crops.

Class 4 land is land which because of inherent soil characteristics, physical or environmental features is not suitable for regular cultivation but with adequate protection is suitable for usage that would involve short periods of cultivation. In this class slopes are steep and soils highly susceptible to erosion under cultivation.

Class 5 land is land which due to one or more inherent soil characteristics, physical or environmental features is not suitable for cultivation.

This land is characterized by very steep slopes and high susceptibility to erosion. Most of the land of this class is unsuitable for even occasional cultivation but will support some range or pasture vegetation. Much of it is even unsuitable for grazing and should be protected for water shed cover only.

According to land use capabilities, based upon five years of soil conservation work, recommendations for the Los Posas area and lands representative are as follows:

(Note: Revision of land use capabilities now in progress. - GLL)

Class 1. Suitable for cultivation without conserving practices.

Soil types.

Panoche loamy sand	Sorrento silty clay loam
Panoche gravelly sandy loam	Sorrento silty clay
sp ✓ Panoche loam	Yolo loamy sand
sp ✓ Panoche clay loam	Yolo sandy loam
Sorrento loamy sand	Yolo loam
Sorrento sandy loam	Rincon silty clay
Sorrento loam	Rincon silty clay loam
Sorrento clay loam	Rincon clay loam
	Rincon loam

Slopes.

0 to 2 percent (slope class A)

Erosion.

Ranging from no apparent erosion to moderate erosion (erosion classes 1, 1.7, and 2).

Crop adaptation.

sp Irrigated land; Beans, sugar beets, alfalfa, truck crops, citrus avocados, walnuts.

Recommendations.

Types of use: Crop land and orchard land.

Rotations: Row crops followed by a winter legume green manure crop for soil improvement on one-third the area cropped each year.

Treatment: Crop rotation, incorporation of crop residues, orchard cover cropping and fertilization.

Practices: No special practices. Soils are productive, free from erosion hazards and conditions unfavorable for cultivation.

Class 2. Suitable for cultivation
with simple soil conserving practices.

Types of soil.

Panoche gravelly sandy loam (Sorrento substratum phase)	Yolo loamy sand (Rincon substratum phase)
Panoche loam (Sorrento substratum phase)	Yolo sandy loam
Panoche loam (Rincon substratum phase)	Yolo sandy loam (Sorrento substratum phase)
Panoche clay loam (Sorrento substratum phase)	Yolo sand loam (Rincon substratum phase)
Panoche clay loam (Rincon substratum phase)	Yolo loam
Panoche gravelly sandy loam	Yolo loam (Rincon substratum phase)
Panoche loam	Altamont clay loam
Panoche clay loam	Altamont silty clay loam
Sorrento loamy sand	Rincon silty clay
Sorrento sandy loam	Rincon silty clay loam
Sorrento loam	Rincon clay loam
Sorrento clay loam	Rincon loam
Sorrento silty clay loam	Yolo loamy sand
Sorrento silty clay	Rincon clay loam (Compact subsoil phase)
Yolo loamy sand (Sorrento substratum phase)	Huerhuero fine sandy loam
	Huerhuero loam

Slopes.

0 to 10 percent (slopes classes A and B)

Erosion.

Ranging from no apparent erosion to moderate erosion (erosion classes, 1⁺, 1⁺7, 2, 27 and 28)

Crop adaptations.

Irrigated land; Beans, sugar beets, alfalfa, truck crops, citrus,
97 av²acados, walnuts.

Dry land: Beans, truck crops, hay and grain.

Recommendations.

Types of use: Crop land, orchard land and permanent vegetative cover.

Rotations: Irrigated land (slopes 0 to 6 percent): Row crops followed by a winter legume green manure crop on one-third the area cropped each year.

Dry farmed land (slopes 6 to 10 percent): Three year rotation with one year hay or grain and two years beans or truck crops. Strip cropping with ~~two~~^{one}-thirds the area in row crops and/or winter fallow and ~~one~~^{two}-thirds in hay or ~~grain~~^{winter cover} each year. Hay or grain seeded with sweet clover for green manure and soil improvement.

Treatment: Crop rotation, incorporation of crops residues, fertilization, orchard cover cropping and fertilization.

Practices: Crop land: Contour tillage, rough or trashy fallow, basin listing, terracing, strip cropping, annual ditches or ridges, gully control, vegetated water ways and for soil protection and improvement--crop rotation, incorporation of crop residues and green manure crops.

Orchard land: Contour cultivation, basin listing, water diversions, gully control, vegetated water ways, mulching, permanent or annual cover crops for soil protection and improvement, fertilization, improved irrigation methods.

Permanent vegetative cover: Woodland and wildlife plantings, grass and legume seeding, gully control, water diversions, fire and grazing protection.

Class 3. Suitable for cultivation
with complex or intensive soil conserving
practices.

Soil types.

Panoche loam
Yolo sandy loam
Yolo loam
Rincon silty clay
Rincon silty clay loam
Rincon clay loam
(Compact subsoil phase)
Rincon clay loam
Rincon loam
Huerhuero gravelly sandy loam
Huerhuero fine sandy loam
Huerhuero loam
Panoche clay loam

Sorrenty sandy loam
Sorrento loam
Sorrento clay loam
Sorrento silty clay loam
Yolo sandy loam
Yolo loam
Rincon silty clay loam
(Compact subsoil phase)
Altamont silty clay
Altamont clay loam
Altamont loam
Altamont sandy loam
Altamont gravelly sandy loam

Slopes.

2 to 25 percent (slopes classes B and C).

Erosion.

Ranging from slight erosion to moderately severe erosion (erosion classes 27, 28, 3, 37 and 38).

Crop adaptation.

Irrigated land: Beans, truck crops, alfalfa, citrus, walnuts and avocados.

Dry land: Beans, truck crops, alfalfa, hay and grain, pasture, grasses, forage plants, and woodland plantations.

Recommendations.

Types of use: Crop land, orchard land, pasture and permanent vegetative cover.

Rotations: Irrigated land (slopes 0 to 6 percent): Row crops followed by a winter legume green manure crop on one-half to two-thirds the area cropped each year.

Dry farmed land (slopes above 6 percent): Three year rotation - one year of hay or grain alternating with two years of beans or truck crops; two year rotation - beans or truck crops rotated with hay or grain every other year; three year rotation - hay or grain first year volunteer pasture second year, beans or truck crop third year; five year rotation - alfalfa three years alternating with two years of beans on slopes above 15 percent. Sweet clover seeded with hay or grain for soil improvement.

Treatments and practices: Crop land: Contour tillage, rough or trashy fallow, basin listing on permeable soils, terracing and strip cropping on slopes below 10 percent, diversion ditches and dikes, gully control, mechanical and vegetative control in discharge channels and for soil conservation and improvement, crop rotation, incorporation of crops residues and fertilization.

Orchard land: Contour cultivation, bench terracing, basin listing, diversion ditches or dikes, mechanical and vegetative control of outlet channels, gully control, mulching, cover crops or permanent cover and fertilization for soil conservation and improvement, improved irrigation methods.

Pastures: Managed grazing, seeding and reseeding, brush removal, mowing for weed control, fertilization, contour furrowing, water spreading, fencing gullies and gully control, fire protection.

Permanent vegetative cover: Water diversions, gully control, woodland and wildlife planting, grass and legume seeding, fire and grazing protection.

Class 4. Not suitable for continuous cultivation.

Soil types.

Altamont clay loam	Rincon clay loam
Altamont silty clay	(Compact subsoil phase)
Altamont loam	Rincon clay loam
Altamont sandy loam	Rincon loam
Altamont gravelly sandy loam	Rincon silty clay
Rincon silty clay	(Compact subsoil phase)
Rincon silty clay loam	Huerhuero gravelly sandy loam
	Huerhuero fine sandy loam
	Huerhuero loam

Slopes.

10 to 25 percent (slope class C).

Erosion.

Moderate to severe erosion (erosion classes 37, 38 and 4)

Crop adaptation.

Dry land: Hay or grain, beans, alfalfa and pasture grasses, forage plants and woodland plantations.

Irrigated land: Citrus and avacados.

Recommendations.

Types of use: Crop land, pasture and permanent vegetative cover.

Rotations: Two year rotation - one year hay or grain rotated with beans every other year; three year rotation - hay or grain first year volunteer pasture second year, beans third year; five year rotation - alfalfa three years alternating with two years of beans. Sweet clover seeded with hay or grain for soil improvement.

Treatments and practices: Crop land: Contour tillage, rough or trashy fallow, diversion ditches or dikes, gully control, mechanical control in discharge channels and for soil conservation and improvement, crop rotation, incorporation of crops residues and fertilization.

Orchard land: Bench terracing, contour cultivation, mechanical control of outlet chammels, gully control, mulching, cover crops or permanent cover and fertilization for soil conservation and improvement, improved irrigation methods.

Pastures: Managed grazing, seeding and reseeding, brush removal, mowing for weed control, fertilization, contour furrowing, water spreading, fencing gullies and gully control, fire protection.

Permanent vegetative cover: Water diversions, gully control, woodland and wildlife planting, grass and legume seeding, fire and grazing control.

Class 5-A. Not suitable for cultivation
Limited or controlled grazing

Soil types.

Rincon silty clay	Altamont clay loam
Rincon silty clay loam	Altamont silty clay
Rincon silty clay	Altamont loam
(Compact subsoil phase)	Altamont sandy loam
Rincon clay loam	Altamont gravelly sandy loam
(Compact subsoil phase)	Huerhuero gravelly sandy loam
Rincon clay loam	Huerhuero fine sandy loam
Rincon loam	Huerhuero loam

Slopes.

25 percent and over (slope class D).

Erosion.

Ranging from severe erosion to erosion essentially destroying the area for tillage (erosion classes 4, 47, 48, 5, 57, 58 and 9).

Crop adaptation.

Pasture grasses, forage plants and woodland plantations.

Recommendations.

Permanent pasture and premanent vegetative cover.

Treatments and practices: Pastures: Grazing control, brush removal, seeding and reseeding, fertilization, fencing gullies and gully control.

Permanent vegetative cover: Fire and grazing protection, woodland and wildlife planting, grass and legume seeding, water diversions and catchment basins.

Class 5-B. Not suitable for cultivation.
No grazing.

Soil types.

Altamont sandy loam	Huerhuero gravelly sandy loam
Altamont gravelly sandy loam	Huerhuero fine sandy loam
	Huerhuero loam

Slopes.

25 percent and over (slope class D).

Erosion.

Very severe erosion including areas essentially destroyed for tillage (erosion classes 48, 5, 57, 58 and 9).

Crop adaptation.

Non cultivable.

Recommendations.

Types of use: Permanent vegetative cover.

Treatments and practices: Fire and grazing protection, water diversions, catchment basins.

Schedule 1. Farms and farm acreage by size, classified according to ownership tenure and status of cooperation.
Las Posas Project, January 1, 1939

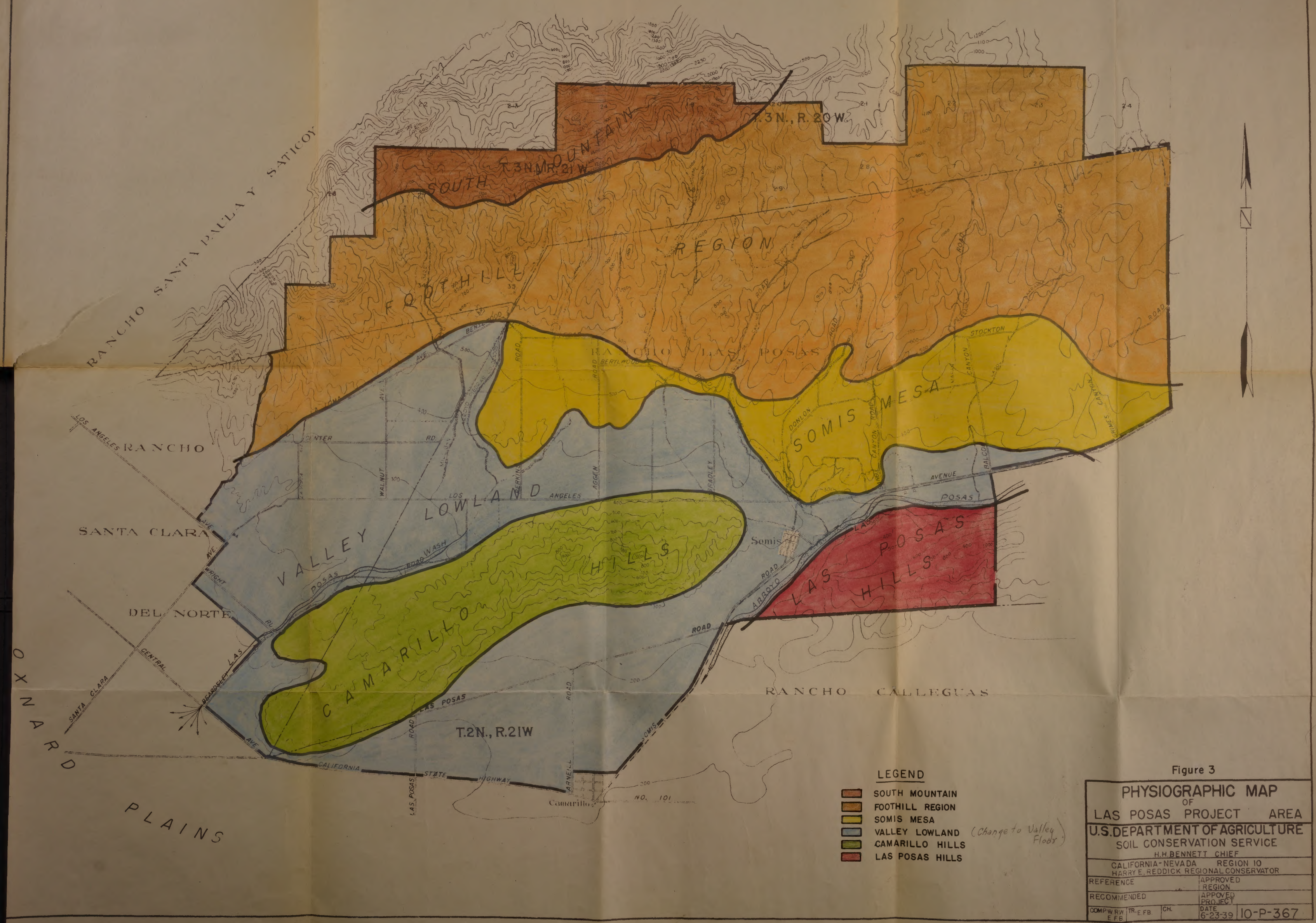
Size of Farm (1)	Coopera- tion (2)	Corporation Owned				Individually Owned						Total All Farms	
		Tenant Operated		Manager Operated		Owner Operated		Tenant Operated		Manager Operated			
Acres		No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres
3-9	C					3	14					3	14
	NC					35	173	2	8			37	181
	T					38	187	2	8			40	195
10-19	C					7	101			1	12	8	113
	NC			1	17	8	108	2	21			11	146
	T			1	17	15	209	2	21	1	12	19	259
20-49	C			2	89	8	276	1	24	1	48	12	437
	NC	1	35	2	62	22	726	6	224	2	86	33	1133
	T	1	35	4	151	30	1002	7	248	3	134	45	1570
50-99	C			1	76	13	963	3	240	2	141	19	1420
	NC	2	148	2	124	17	1203	8	613	2	119	31	2207
	T	2	148	3	200	30	2166	11	853	4	260	50	3627
100-174	C			4	593	11	1560	10	1470	2	321	27	3944
	NC	1	160	7	978	14	1768	9	1313			31	4219
	T	1	160	11	1571	25	3328	19	2783	2	321	58	8163
175-259	C	4	817			3	614	3	553	2	408	12	2392
	NC	4	878	4	814	4	844	5	1065	2	430	19	4031
	T	8	1695	4	814	7	1458	8	1618	4	838	31	6423
260-499	C	3	910	2	667	1	341	4	1293	4	1391	14	4602
	NC	1	499	4	1079	1	340	4	1527	2	643	12	4088
	T	4	1409	6	1746	2	681	8	2820	6	2034	26	8690
500-999	C	1	786			3	1668	2	1212			6	3666
	NC			1	823			1	525			2	1348
	T	1	786	1	823	3	1669	3	1737			8	5014
1000-over	C									1	1088	1	1088
	NC	1	1200					1	1261			2	2461
	T	1	1200					1	1261	1	1088	3	3549
Total: Project Area	C	8	2513	9	1425	49	5537	23	4792	13	3409	102	17676
	NC	10	2920	21	3897	101	5162	38	6557	8	1278	178	19814
	T	18	5433	30	5322	150	10699	61	11349	21	4687	280	37490
Average size	C		314		159		113		208		262		173
	NC		292		186		51		173		160		111
	T		302		177		71		186		223		134
Percent of farms	C	44		30		33		38		62		36	
	NC	56		70		67		62		38		64	
	T	100		100		100		100		100		100	
Percent of acreage	C		46		27		52		42		73		47
	NC		54		73		48		58		27		53
	T		100		100		100		100		100		100

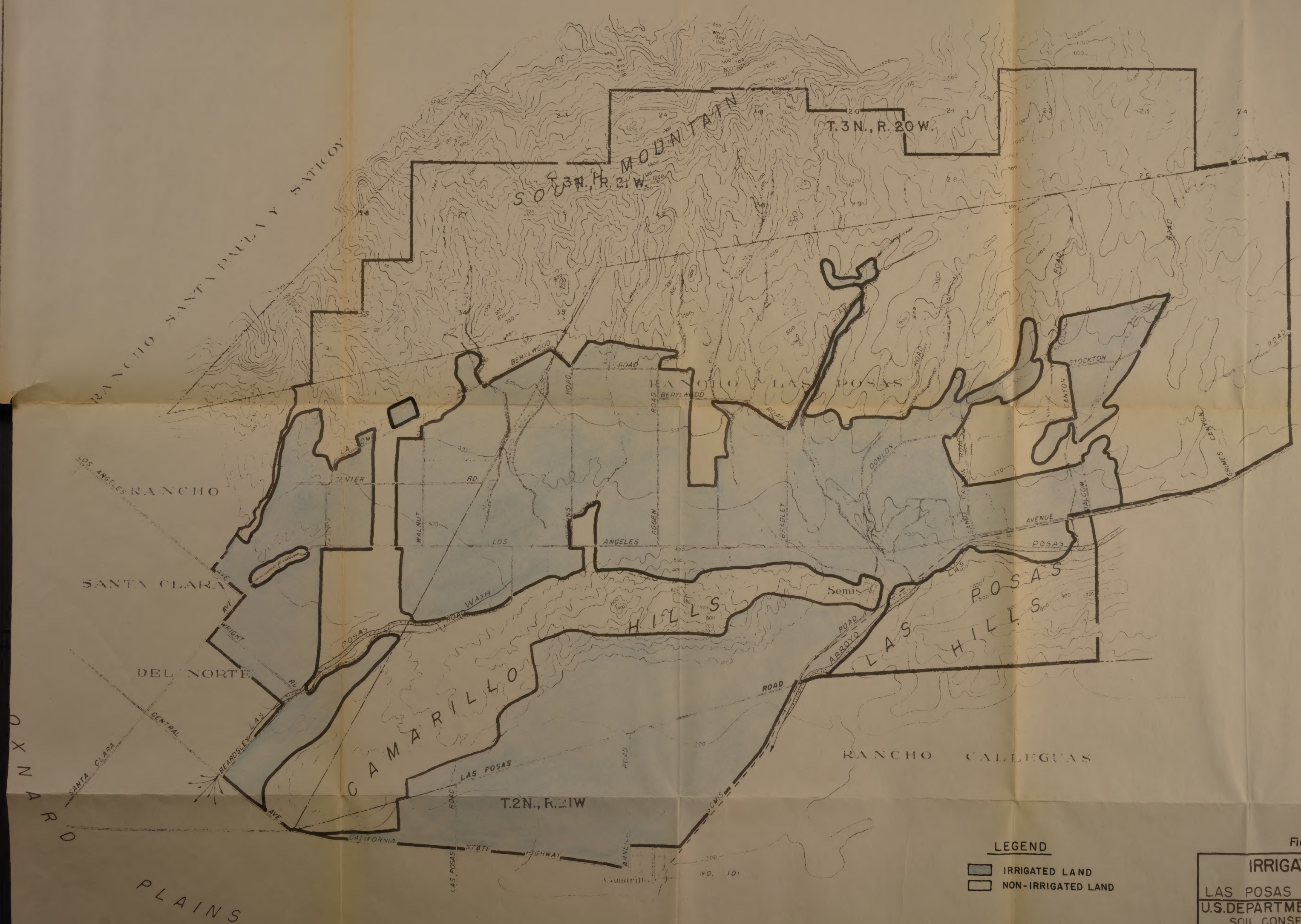
(1) Under three acres, being residential homesites, have been excluded.

(2) C - cooperating farms; NC - noncooperating farms; T - total.

Schedule 1. Farms and farm workers by size, classified according to the Forest Project, January

Farms (1)	Cooperatives (2)	Tenant Operated			Manager Operated			Owner Operated	
		No.	Acres	No.	No.	Acres	No.	Acres	No.
0-10	C							3	3
	MC							33	1
	T							33	1
10-20	C							7	1
	MC				1	17		8	1
	T				1	17		15	3
20-30	C				2	33		18	2
	MC	1	33		2	33		33	7
	T	1	33		4	133		30	10
30-40	C				1	78		13	9
	MC	2	133		2	133		17	13
	T	2	133		3	200		30	21
40-50	C				4	200		11	13
	MC	1	130		7	278		14	14
	T	1	130		11	1371		32	33
50-60	C	4	317					13	8
	MC	4	378		4	378		14	8
	T	8	1333		6	314		7	13
60-70	C	2	310		2	337		1	3
	MC	1	233		4	1073		1	3
	T	4	1403		8	1743		2	9
70-80	C	1	733					2	13
	MC				1	333			
	T	1	733		1	333		3	13
80-90	C								
	MC	1	1300						
	T	1	1300						
90-100	C	3	3313		3	1433		43	33
	MC	10	3330		21	3337		101	31
	T	13	3433		20	3333		130	103
100-110	C								
	MC								
	T								
110-120	C								
	MC								
	T								
120-130	C	44	33		20			33	
	MC	33			70			37	
	T	100			100			100	



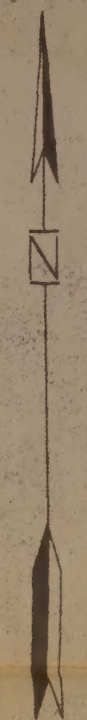
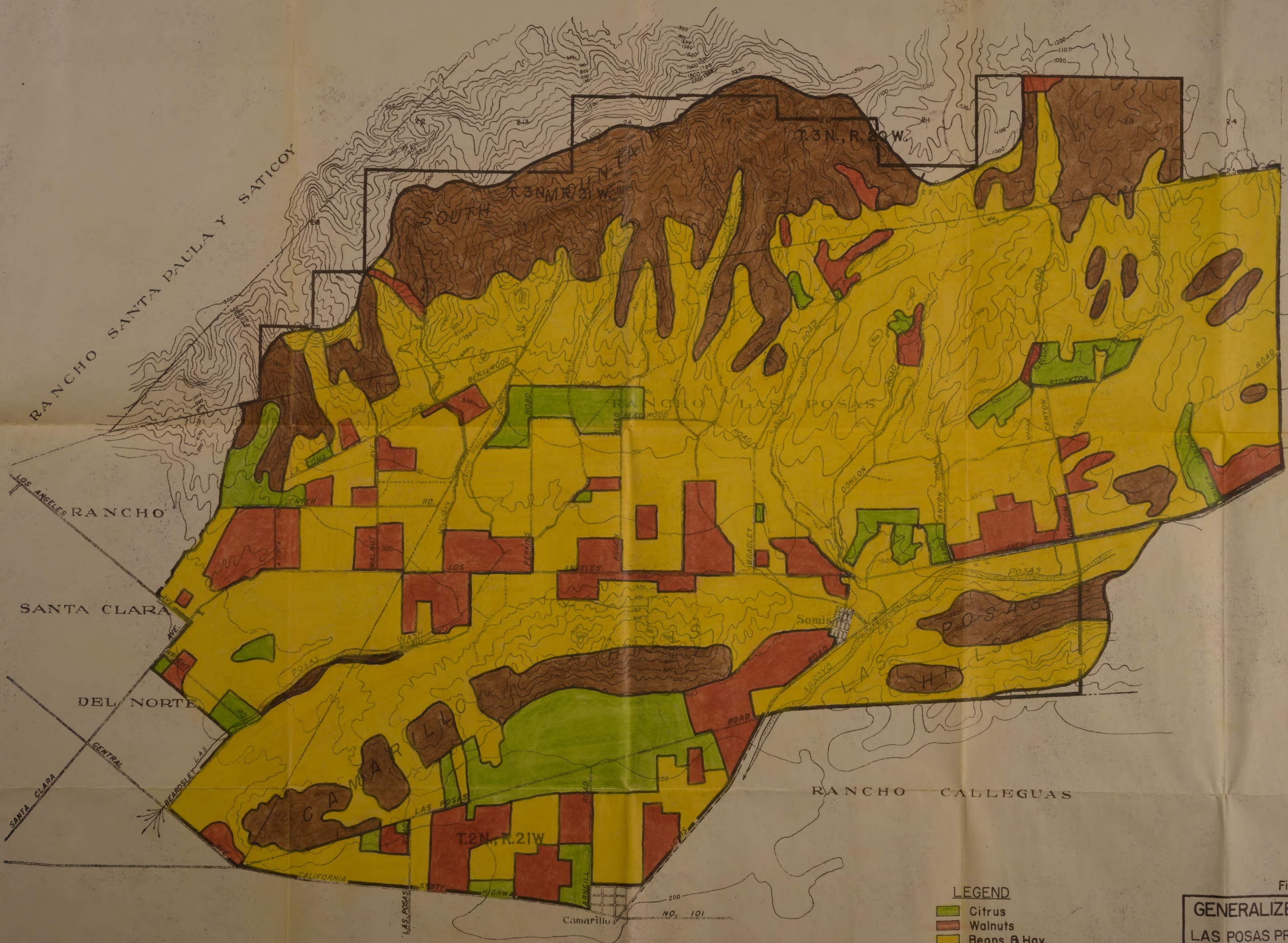


LEGEND

- IRRIGATED LAND
- NON-IRRIGATED LAND

Figure 9

IRRIGATION MAP			
OF			
LAS POSAS PROJECT AREA			
U.S. DEPARTMENT OF AGRICULTURE			
SOIL CONSERVATION SERVICE			
H. H. BENNETT CHIEF			
CALIFORNIA-NEVADA REGION 10			
HARRY E. REDDICK REGIONAL CONSERVATOR			
REFERENCE	APPROVED REGION		
RECOMMENDED	APPROVED PROJECT		
COMP. W. R. W.	TR. E. F. B.	CH.	DATE
E. F. B.			6-24-39 10-P-366

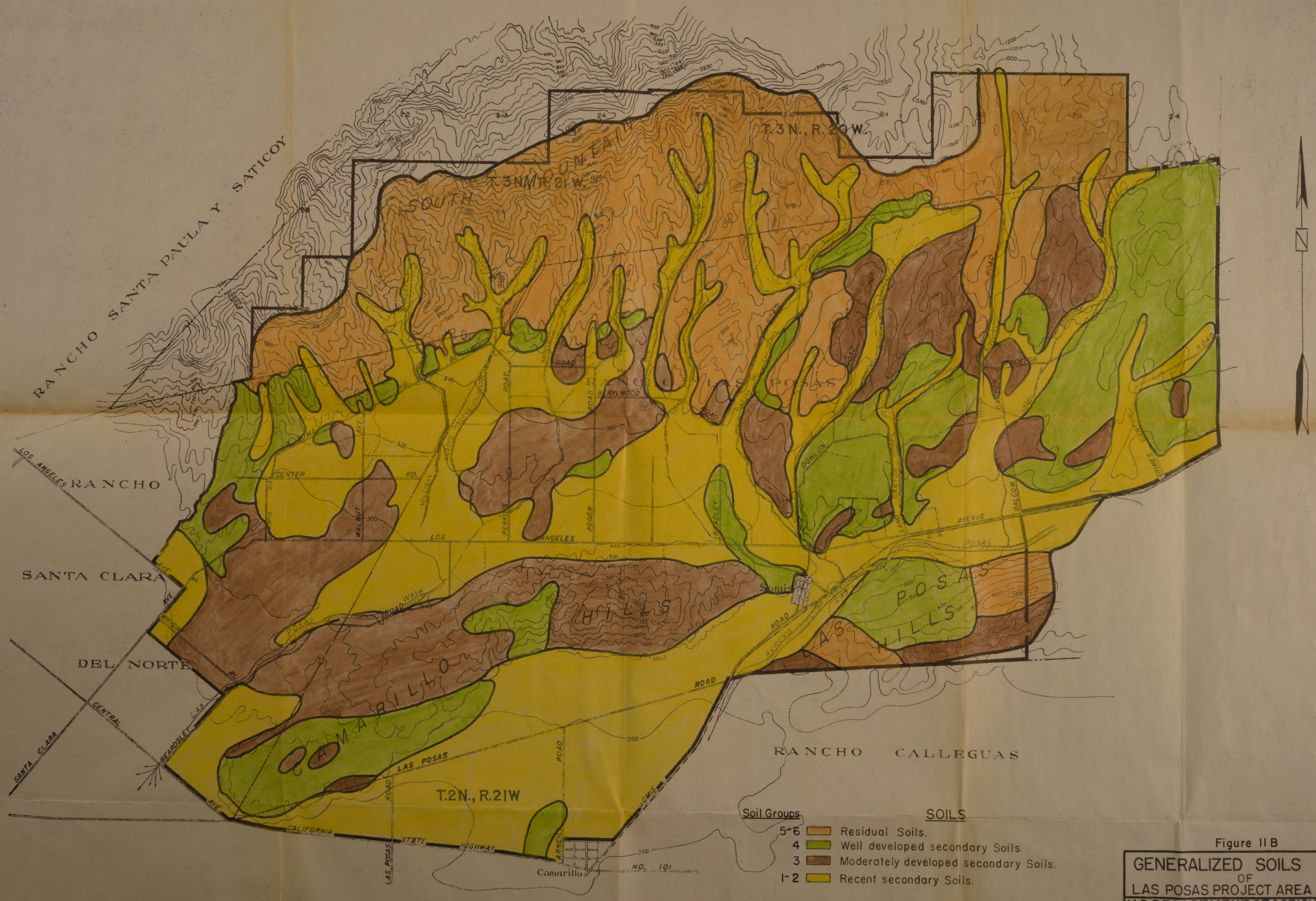


LEGEND

- Citrus
- Walnuts
- Beans & Hay
- Idle & Pasture

Figure IIA

GENERALIZED LAND USE MAP			
OF			
LAS POSAS PROJECT AREA 1936			
U.S. DEPARTMENT OF AGRICULTURE			
SOIL CONSERVATION SERVICE			
H.H. BENNETT CHIEF			
CALIFORNIA-NEVADA REGION 10			
HARRY E. REDDICK REGIONAL CONSERVATOR			
REFERENCE	APPROVED REGION		
RECOMMENDED	APPROVED PROJECT		
COMP. W. RW. E.F.B.	TR. E.F.B.	CH.	DATE 6-29-39 10-P-368



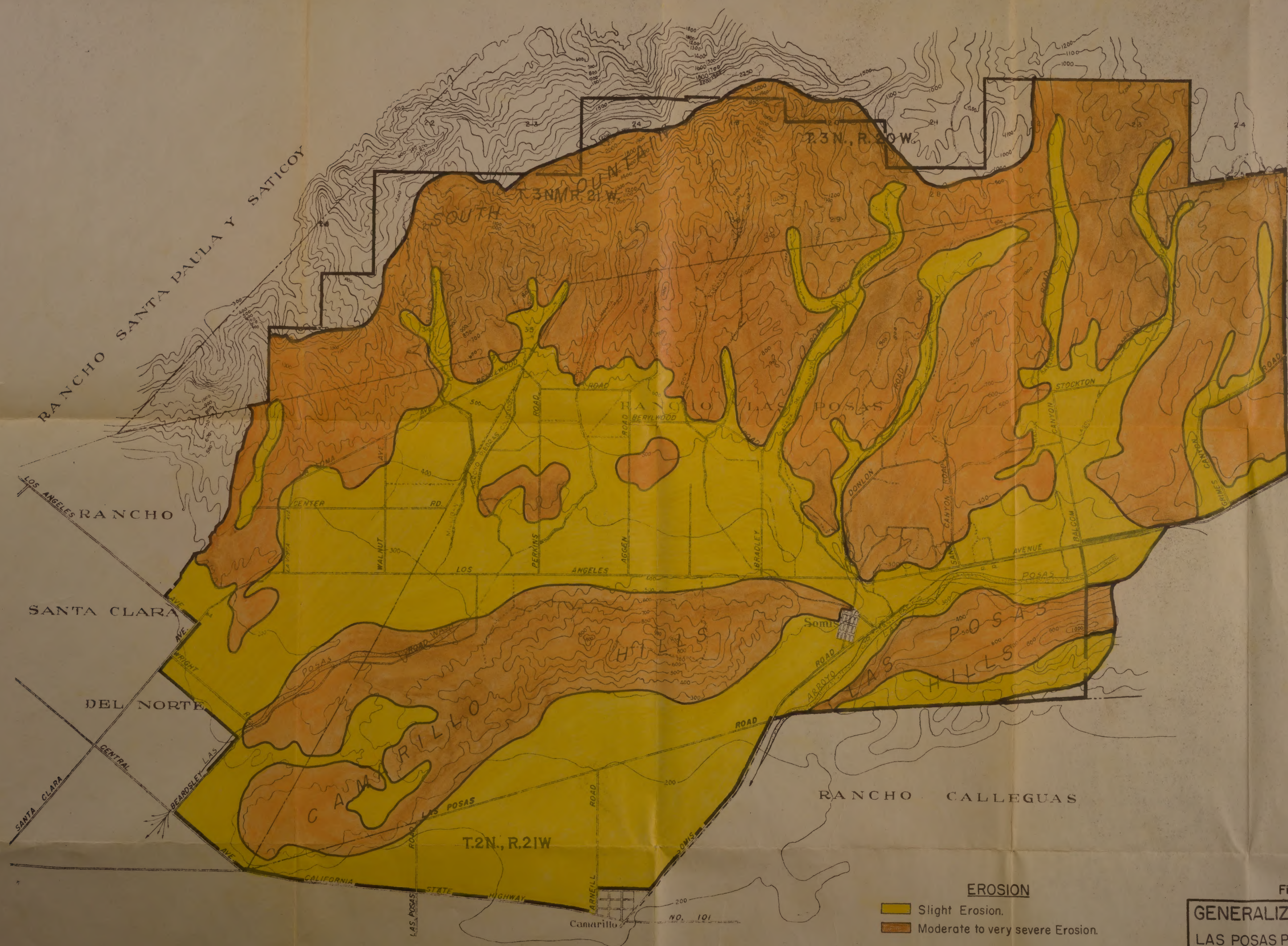
- Soil Groups**
- 5-6 Residual Soils.
 - 4 Well developed secondary Soils.
 - 3 Moderately developed secondary Soils.
 - 1-2 Recent secondary Soils.

Figure 11 B

GENERALIZED SOILS MAP
OF
LAS POSAS PROJECT AREA 1936
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H.H. BENNETT CHIEF
CALIFORNIA-NEVADA REGION 10
HARRY E. REDDICK REGIONAL CONSERVATOR

REFERENCE	APPROVED REGION
RECOMMENDED	APPROVED PROJECT
COMP. W. RW. E.F.B.	TR. E.F.B. CH. DATE 6-25-1939

10-P-369



EROSION

■ Slight Erosion.

■ Moderate to very severe Erosion.

Figure II C

GENERALIZED EROSION MAP			
OF			
LAS POSAS PROJECT AREA 1936			
U.S. DEPARTMENT OF AGRICULTURE			
SOIL CONSERVATION SERVICE			
H.H. BENNETT CHIEF			
CALIFORNIA-NEVADA REGION 10			
HARRY E. REDDICK REGIONAL CONSERVATOR			
REFERENCE	APPROVED		
	REGION		
RECOMMENDED	APPROVED		
	PROJECT		
COMP. W. RW	TR. E. FB.	CH.	DATE
E. FB.			6-28-1939
			10-P-370

LAS POSAS PROJECT MONOGRAPH

List of photographs by page number, figure number and accession number.

Page No.	Figure No.	Accession No.
7	2	7-658
9	4	Cal-5095
11	5	7-2600
15	6	(1)
37-A	7 (A)	Cal-5089
	(B,C)	" -4950
37-B	(D)	" -4998
38	8	(1)
43-A	10	Cal-3615
62-A	12 (A)	" - (1)
	(B)	" -4192
	(C)	" -4217
75	13	" -4396
77	14	7-1755
81	15	Cal-4923
82	16	" -3016
89	17	" - 4947 (1)
90	18	7-288C
90	19	Cal-4408
91	20	" -4198
92	21	1308 A
96	22	Cal-3019
97	23	7-851 A
98	24	Cal-4559
102	25	" -3321
106	26	" -4851
107-A	27	" -3475
		Cal-4224
112	28	(1)
118	29	Cal-4519
120	30	" -4926
126	31	" -4943

(1) See regional photographic files or regional photographer.

